NATURE

No. 4422 SATURDAY, JULY 31, 1954 Vol. 174

CONTENTS

	Page
Coastal Flooding in Britain	193
Original Papers of Wilbur and Orville Wright. By Ernest F. Relf, C.B.E., F.R.S.	195
University of Leeds : Jubilee Volume. By Prof. R. Whiddington, C.B.E., F.R.S.	196
Flowers and Fungi. By Prof. Ronald Good	197
Chemical Analysis of Industrial Solvents. By C. Whalley	197
What is Known about Sleep. By Prof. N. Kleitman	198
Rice Substitutes. By V. Subrahmanyan, D. S. Bhatia, M. Swaminathan and G. S. Bains	199
Rheology in Mechanical Engineering	201
The Royal Netherlands Meteorological Institute (1854–1954). By Prof. W. Bleeker	203
Obituary : Mr. F. Morley Colebrook, O.B.E. By Dr. R. L. Smith-Rose, C.B.E.	204
News and Views	205
Technical Colleges and Industry in Britain	210
Canada's To-morrow. By Robert W. Steel	212
The Sports Turf Research Institute : Silver Jubilee	213
Development and Utilization of Water Resources. By Dr. W. G. V. Balchin	213
Network Analyser of the Electrical Research Association	214
Family Planning	215
Salmon Migration and the Environment. By Prof. A. G. Huntsman	215
Paper Chromatography as a Tool for Mosquito Taxonomy : the *Culex pipiens* Complex. By Dr. Don W. Micks	217
New Types of Interference Filters of Greater Areas and Higher Contrast. By A. Hermansen	218
Letters to the Editors :	
Dawn and Dusk Flight of *Drosophila subobscura* Collin.—L. R. Taylor and Dr. H. Kalmus	221
An Epizootic among Laboratory Stocks of the Desert Locust, *Schistocerca gregaria* Forsk.—J. P. Stevenson	222
Conception in Prepuberal Mice following Artificially Induced Ovulation and Mating.—Meredith N. Runner and Allen Gates	222
Transport of Chloride in the 'Symplasm' of *Vallisneria* Leaves.—Prof. W. H. Arisz	223
Structural Analogies of Pox Viruses and Bacteria.—Dr. D. Peters and W. Stoeckenius	224
Isolation of *Keratinomyces ajelloi* from Soils in Great Britain.—Dr. Geoffrey Daniels	224
Effects of Antibiotics on Carbon Dioxide Production in Soil.—T. Vincents Nissen	226
Nutritive Value of Lucerne Protein Concentrates, fed with and without Cholesterol.—S. J. Cowlishaw, D. E. Eyles, W. F. Raymond and J. M. A. Tilley	227
Pentoses associated with Jute α-Cellulose.—Dr. D. B. Das, M. K. Mitra and J. F Wareham ; Dr. P. B. Sarkar.	228
Abdominal Lymphatic Tissue as a Source of Hyperglycæmic Glycogenolytic Factor.—M. R. Raja Rama Rao and Dr. N. N. De	229
Inhibition of the 'Condensing Enzyme' of *Aspergillus niger* by Magnesium.—C. V. Ramakrishnan and S. M. Martin	230
New Synthetic Antispasmodics.—Dr. J. Cymerman-Craig, K. V. Martin, P. C. Wailes, Prof. R. H. Thorp, R. Ladd and G. Thorburn	231
Efficiency of Oxidative Phosphorylation.—Prof. Henry Lardy and J. H. Copenhaver, jun.	231
Chemical Form of Phosphorus-32 produced in Aluminium by Bombardment with Nitrogen.—Dr. G. A. Chackett and K. F. Chackett	232
Methods of Calculation of Polarographic Currents for Depolarization Schemes involving Reactions of Higher Order.—Dr. Jaroslav Koutecky	233
Oxygen-18 Abundance in Fresh Water.—Willi Dansgaard	234
Odour and Chemical Constitution.—Prof. J. Timmermans	235
Caution in the Use of Liquid Propane for freezing Biological Specimens.—Dr. John L. Stephenson	235
Recent Scientific and Technical Books	Supp. viii

COASTAL FLOODING IN BRITAIN

THE recently published report* of the Departmental Committee on Coastal Flooding is of considerable interest to a wide variety of authorities and individuals. The Committee was appointed in April of 1953 and was charged with the task of examining the causes of the floods on the east coast of Britain which had occurred in the previous January, and with estimating the possibilities of their recurrence. The Committee was also asked to consider what margin of safety for sea defences would be reasonable having regard to the estimated risks and the cost of protective measures, and whether any system of warning was desirable to lessen the risk of loss of life and damage to property. Finally, the existing administrative and financial structure for the maintenance and replacement of sea defences was to be reviewed.

With commendable speed and efficiency the Committee has studied the problem and made its report and recommendations in a little more than twelve months. Indeed, it had already distinguished itself by the early publication of an interim report on a warning system which appeared in July 1953. Priority was given to this aspect of the terms of reference in view of the public anxiety which had been created by the tragic events of January 1953, when more than three hundred people lost their lives, some 24,000 houses and more than 200 large industrial premises were flooded and damaged, and some 160,000 acres of land inundated.

The Committee proposed in this interim report that a winter warning system should operate initially on the east coast of Britain between September 15 and April 30 each year. It was suggested that water-level reports should be sent in to the Central Forecasting Office at Dunstable, where a seconded officer of the Hydrographic Department of the Admiralty would interpret them in the light of predicted tidal levels and the possibility of surges. If dangerous levels were likely to be exceeded, then the river boards and county police were to be informed immediately, and were locally to be charged with the responsibility of giving adequate warning. This system was put into operation and has apparently stood the test of a trial winter season quite satisfactorily.

As is now well known, the severe coastal flooding of January 1953 was caused by the combination of a fairly high tide with a very high surge, and the effect was increased by severe wave action. Tidal oscillations are well-known phenomena and can be predicted with reasonable accuracy, but the surge has only been recognized and studied in the past thirty years. A surge is mainly due to strong winds blowing forward the surface waters of the sea ; this in certain circumstances may lead to an accumulation of water in a particular locality and hence to a rise

* Report of the Departmental Committee on Coastal Flooding. (Cmd. 9165.) Pp. 48. (London : H.M.S.O., 1954.) 2s. 6d. net.

in sea-level. Smaller differences in level may also be produced by changes in atmospheric pressure from one part of the sea to another. The surge is therefore clearly a meteorological phenomenon, although once the accumulation (or deficit) of water has been formed in any region it will tend to move away from that region according to the laws of mechanics. Forecasting the incidence and periodicity of a surge is difficult, although once established a fairly reasonable estimate of the dispersal behaviour can be made. Here the Committee is strongly in favour of more fundamental research being carried out in order that the warning system can be further improved.

The primary causes of tides and surges are completely unrelated, so that it might seem a maximum in both could coincide. Their combination is not, however, a simple superposition. In steady conditions the slope on the surface produced by a given wind varies inversely with the total depth of water under the wind, so that when the tide is high the slope of the sea surface is somewhat less than when the tide is low. The highest surges have, in fact, reached their greatest heights when the tides have been nearer low water than high water. The flood of January 1953 did not occur at high tide, nor did it occur with the highest spring tides; and the surge, although 9 ft. in height and exceptional, was not the greatest on record. A moderate surge coming near high water on a high spring tide is thus likely to prove even more disastrous. Here again, further information is needed before the precise nature of the interaction between the tide and surge can be understood.

Another somewhat disturbing factor which the investigation has brought to light is the progressive increase over the past hundred years in the highest levels reached in exceptional storms and in the frequencies with which such levels occur on the east coast of Britain. This is largely attributed to the steady rise of mean sea-level relative to the land which appears to be taking place at the rate of one foot per century along the coasts of south-eastern England. Attention is further directed to the effect of large waves upon the coastal defences, since the meteorological conditions favourable to surges will also produce exceptional waves. It also becomes necessary to bear in mind the possibility of upland river flood water adding to tidal and surge waters in constricted estuaries—an important point in the problem of the Thames estuary.

Having established the causes of the severe flooding and shown where additional information is desirable, the report then considers the practical problems of coastal defence which arise on the east coast. Here there are long stretches of natural defences such as dunes and shingle ridges, to which has been added some 1,270 miles of man-made earthen and other types of banks: the whole protecting considerable areas of land now lying well below high-tide level. To reinforce all these defences to meet the maximum water-level that is theoretically possible in the light of present knowledge would of course be financially out of the question. The Committee recommends that the level of January 1953 should be taken as a reasonable working basis for areas of high property value; elsewhere defences should be at a standard which would have been thought reasonable prior to January 1953. But preparations should be made where desirable to deal with a limited amount of overspill for occasional exceptional water-levels (the statistical chance of the January 1953 level is once in every two hundred years). Where possible, second-line defences should be strengthened or constructed to create a cell or honeycomb structure which would contain any overspill flood waters during an emergency. Where the risk of overtopping is accepted, earthen banks should be waterproofed with a carpet of material such as asphalt/concrete to prevent erosion on the back slopes and the consequent collapses which were so common in 1953. The sealing of minor tidal creeks is recommended, and the possibility of deliberately spilling water on the seaward side of vulnerable areas is also considered.

The importance of maintaining the natural defences of dunes and shingle ridges is stressed, together with the advisability of pressing ahead with research on the behaviour and suitability of binding and stabilizing vegetation for use on such areas. The Committee might also have mentioned the need for a code of public behaviour in such localities—few holiday-makers and caravan dwellers realize how deleterious their activities can be to the natural coastal defences. Further research is also considered advisable into the movements of beach material and offshore sand banks, together with the use of groynes as a control medium for beach retention; conflicting evidence was deposited with the Committee relative to these problems.

Finally, the field of existing responsibilities for the coast protection and defences of eastern England is surveyed. As might be expected, there is here a complex situation with duties spread over river boards, county borough councils, county district councils and government departments, with here and there a part of the coast completely 'unadopted'. After careful consideration, however, the Committee does not recommend any change in the distribution of existing responsibilities, but does advise in some instances closer co-operation between certain authorities. Financial responsibilities are also considered in the report, and an effort is made to lay down some working principles on the problem of who should pay for construction and maintenance of the defences.

The special problem of flooding in the Thames receives separate consideration. A surprising amount of the City of London is built on former marsh land and is now below high-tide level; substantial areas would be flooded if the embankments were overtopped or gave way. The 1953 flood water generally reached the top of the city defences, and lower downstream some 30,000 acres were inundated. It was fortunate that the down-river inflow was so low or much greater damage would have resulted.

Experiments have since been made on the Port of London Authority's tidal model of the Thames to study the interaction of river flow, tidal changes and surge effects. A complicated picture emerges, as a

solution in one locality may intensify the problem elsewhere. Thus the raising of the downstream defences in Kent and Essex by 3–4 ft. which followed immediately upon the flood of 1953 will appreciably raise the Thames level in central London should such an incident be repeated; further, any greater surge height at Southend means a progressively greater increase in height upstream towards London Bridge. Relief by means of controlled spill is now almost impossible, and similarly the raising of the defences of inner London would be extremely difficult and costly because of the associated ancillary work. Two other possibilities were there re considered: one method would be to erect a bar er across the estuary, leaving gaps through which shipping could pass; but this carries the disadvan ge that it would cause deterioration of the estuary. alternative suggestion which was tried out on th model, and which the Committee recommends for rious consideration, was the construction of a suit ole structure across the Long Reach (between Purfleet and Greenhithe) provided with 'gates' which could be closed on occasions of impending high flood.

The report also directs attention to certain unsatisfactory aspects of the present financial and administrative arrangements in the existing Thames flood defence scheme, and to the fact that little positive action followed upon the report of the Hart Departmental Committee of 1931–33, which was set up to consider floods in the tidal portion of the Thames. The present Committee urges that the special problem of the Thames should be resolutely tackled without further loss of time.

This report on coastal flooding is a model of its kind, and one could only wish that the associated, but even more serious and more frequent, problem of river flooding (see *Nature*, **172**, 263 and 823; 1953) was also in receipt of equally careful attention and consideration.

ORIGINAL PAPERS OF WILBUR AND ORVILLE WRIGHT

The Papers of Wilbur and Orville Wright

Including the Chanute–Wright Letters and other Papers of Octave Chanute. Edited by Marvin W. McFarland. (Sponsored by Oberlin College on the Wilbur Wright Memorial Fund, and prepared for the Press, with Notes, Appendices, and Bibliography, by the Aeronautics Division of the Library of Congress.) Vol. 1: 1899–1905. Pp. lv+676+141 plates. Vol. 2: 1906–1948. Pp. xxvii+677–1278+plates 142–236. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 2 volumes, £10.

THESE two volumes give for the first time a full account by the Wright brothers of the history of the solution of the problem of human flight. In the introduction it is explained that they fully intended to write up the results of their work for publication, but that they became so preoccupied with their experiments and later with the marketing of their machines that they never did so. After Wilbur's death in 1912, Orville had the same good intention, but never carried it out. After his death in 1948, the voluminous correspondence of the brothers and their note-books eventually came into the possession of the United States Library of Congress, and it is from this material that the present volumes have been compiled. The story is told almost entirely by the reproduction of the correspondence in full, so far as it affects the progress of the aeronautical work, with an occasional letter that sheds light on the character and personality of the Wrights. By far the greater part of the letters passed between the Wrights and Octave Chanute, with whom they formed a close friendship in the early days and with whom they discussed, usually by writing, the results of their experiments. It is most fortunate that these letters have been preserved.

The books are by no means easy reading, partly because of the great amount of material in them and partly because the Wrights invented their own terminology, and one must translate it into modern aeronautical nomenclature in order to see precisely what they were thinking. There is, however, a very clear picture of the whole process through which they went, from the first desire to explore the possibility of flight to the successful achievement of powered flight for the first time in history and on again to the development of their machines into forms suitable for practical use in peace and war. The first volume carries the reader from 1899 to 1905 and contains chiefly an account of aerodynamic experiments made to determine the basis on which flight depends. This is unfolded almost entirely by the letters to Chanute and his replies, but in appendixes there is an account of the Wright brothers' nomenclature, of their wind-tunnel experiments and results, and of their study of the problem of the propeller. There are also extracts from Chanute's diary which shed further light on the subject.

The second volume contains later experimental work; but is largely taken up with the efforts made by the brothers, sometimes separately and sometimes together, to obtain some reasonable financial recompense for all their work by selling their invention to governments or private companies, a matter in which they met with no small difficulty. There is also an account, amplified by footnotes, of the various controversies which arose concerning the Wrights' claim to have been the first to fly, and, in particular, of the lengthy battle which raged over the claims of Langley, in which the Smithsonian Institution took, at the time, a rather inglorious part, but later fully recanted.

The broad outline of the Wrights' pioneering work is now fairly well known through details which have been given in Wilbur Wright Lectures and in the publications of the Royal Aeronautical Society and other bodies; but it may be well to direct attention here to salient points. The Wright brothers were no theorists, but practical engineers whose life had started in the cycle trade. They realized, from the start, the extreme importance of obtaining numerical data on the performance of their machines as a basis for future progress. They followed, in fact, the road that has been followed ever since in aeronautical research, combining measurements in flight with experiments on models and endeavouring to correlate the two to form a practical basis for design. In the earliest days they used gliders, which they sometimes flew as kites, and by observations of angles of glide and incidence in the former case, and of tension in the cable in the latter, they were able to get a fairly

good quantitative idea of the forces acting on the wings. They soon realized that the existing tables of aerodynamic data, chiefly Lilienthal's, were far from satisfactory, and it was this that led them to devise a wind tunnel in which they could make tests of lift and drag on a whole series of wings of various sections. On these data they based the design of all their subsequent machines, with conspicuous success. They showed the greatest wisdom in their flying, never rising more than a few feet above the ground until they had fully solved the problem of control and had learned how to use that control in all circumstances. They state repeatedly in their letters that the real problem of flight is one of control, rather than the mere provision of wings that can sustain the weight and power to pull them through the air. They did their best to follow the work of others in the field; but it seems fair to say that they owed very little to such work and that from their own resources and tests they evolved the machine, its engine and its propeller, all of which they made with their own hands. This is surely one of the most notable achievements in the history of man. They seem to have been unaware, however, of the writings of Lanchester, and of the theoretical and experimental work of Eiffel and Prandtl; at least, there is no mention of these investigators until almost the last letters of Orville Wright.

It is perhaps surprising that it should be so late before a full account of the Wrights' work has become available. The main reasons are that they themselves did not write out their results, and that they were always careful not to discuss their work, except to close friends, lest they should lose to others some of the credit that they felt was their own. We can now be thankful that the story has at last been told and that the magnificent achievement of the Wright brothers can be appreciated to the full extent it deserves in this air age which they did so much to inaugurate.

Ernest F. Relf

UNIVERSITY OF LEEDS: JUBILEE VOLUME

The University of Leeds

The First Half-Century. By Prof. A. N. Shimmin. Pp. xv+230+8 plates. (Cambridge: At the University Press, 1954. Published for the University of Leeds.) 21*s*. net.

THIS is a remarkable book about a remarkable institution, and a more fitting foreword than that of its Royal Chancellor can scarcely be imagined. The Princess Royal says: "The making of a University calls for inspiration and enterprise. Although the University of Leeds is still young, the men and women who have created and cherished it have displayed the same devotion to truth in the service of their generation as their forbears in the older Universities. This book is the story of a triumph over many obstacles and over the ill effects of two world wars. So much strength and vigour, gained in so short a time, is good testimony to the loyalty and robust energy of the members of the University themselves. But as the record shows, they have not done what they have done in isolation. Through all the years, while steadily building up its esteem in the world of learning, the University has felt a characteristic impulse from the Yorkshire people whom it serves. In a Jubilee celebration it is most fitting to honour those who have laid the foundations and I commend this history to all who care for our University of Leeds. Mary".

In these words Her Royal Highness has most aptly summarized the intention of the jubilee and the purpose of the commemorative volume which the University authorities so wisely entrusted to the care of Arnold Shimmin, professor of social science.

The volume presents a broad, general, historical sketch of the antecedents of the University and makes a most successful effort to indicate the vicissitudes and successes from the days of the Medical School (1831); the Yorkshire College of Science (1874); the amalgamation of these two (1884); the federation of the Yorkshire College in the Victoria University (1887); and lastly the granting of a charter to the infant University of Leeds (1904) and so to 1954.

The first pre-natal stirrings are touched on, with a reference to an account in the *Leeds Mercury* (1826) of a proposal by the president of the Philosophical and Literary Society of Leeds to establish a university in Leeds. The scheme was still-born—but was at any rate a stirring of thought. Who knows but that the processes so started led to the foundation of a School of Medicine in 1831, for was not the first president of its Council one Dr. James Williamson, who had been the first secretary of the Leeds Philosophical and Literary Society?

Prof. Shimmin gives such matters the fullest possible attention in the first of six chapters which make up Part 1 of the book, entitled "The Making of the University". In this part, additional to the historical background, are included also such topics as "The Years of Expansion (1925–53)"; "Student Welfare"; and a revealing section under the title of "Town and Gown".

This Part 1 is the more impersonal of the two main parts into which the book divides itself. Nevertheless, even the casual reader will realize, as has been the treasured realization of all members of the University, that distinguished and well-remembered names were foremost among the original teachers in 1874: Arthur Rucker was professor of physics; A. H. Green was professor of geology; Edward Thorpe was professor of chemistry; and these were soon to be joined by Louis Miall, professor of biology. The Yorkshire College of Science had stepped off on the right foot on its path towards university status and was thus destined, from the start, to be not entirely vocational. Indeed, from one of the appendixes (No. 3) which illumine the historical details, this breadth of vision and balance of study was (as it still is) well maintained, since, at the time of the charter in 1904, there were eleven arts departments, six of science, seven of technology and ten of medicine.

During this fifty years, Prof. Shimmin points out, many distinguished names have helped in the building up of the external prestige of the University and have added to its growing lustre. Such men as George Gordon, Lascelles Abercrombie, Paul Barbier, A. Hamilton Thompson, John Clapham, William H. Bragg, Arthur Smithells, Arthur G. Perkin, Henry Procter, Henry Raper and Berkeley Moynihan all won in their time high international reputations for themselves and for the University. Others are too near the present day to be mentioned in this review; but in Part 2 of his work, entitled "Et Augebitur Scientia"—the University motto—Prof. Shimmin

has, with full justice to all, sung the praise of the present and the immediate past.

But praise for achievement is due not only to the distinguished vice-chancellors and their academic colleagues, but also to those high-minded and far-seeing laymen who have given such ungrudging and helpful service in high administrative and advisory capacity; the functions and purpose, therefore, of all in the hierarchy, from chancellor, through pro-chancellor to members of council and their committees, are set out and particular personalities singled out for special mention. The reader will note with interest, perhaps, that even in the short space of fifty years the outlook and methods of these public-spirited men—often the sons of fathers who have similarly served—have changed in evolutionary manner from the firm, though kindly, autocracy of the past to the gentler advisory guidance of the present.

Many of the illustrations have been charmingly executed by Maurice de Sausmerez, head of one of the youngest University Departments, that of Fine Art; the printing, photographic reproductions and binding are quite impeccable, and the whole effect is most pleasing.

In short, this is a most interesting book, full of information about the University, historically, geographically, architecturally, numerically and financially, but nevertheless it is full also of the human and personal side of a great and continuing endeavour; it will stand as a lasting and authoritative summary of the early life of the rapidly evolving University of Leeds.

R. WHIDDINGTON

FLOWERS AND FUNGI

Wild Flowers

Botanising in Britain. By Dr. John Gilmour and Dr. Max Walters. (The New Naturalist: a Survey of British Natural History.) Pp. xiv + 242 + 56 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 25*s*. net.

Mushrooms and Toadstools

A Study of the Activities of Fungi. By Dr. John Ramsbottom. (The New Naturalist: a Survey of British Natural History.) Pp. xiv + 306 + 71 plates. (London: William Collins, Sons and Co., Ltd., 1953.) 30*s*. net.

IT is said that every age has its book, and the book of the present age would almost seem to be a natural history book, so many are these and so insatiable the demand for them. Why this should be opens up a most interesting field for speculation, and many explanations are offered. Some think that it merely expresses the swing of the pendulum in the fashion in books; but it seems unlikely that this can be the whole story, and many prefer to think that it betokens something more than this and, especially, a growing realization that we have wandered too far from the simple and beautiful, and are now seeking, with no little nostalgia, to recapture something that is escaping us.

Whatever the truth may be, there is now an immense array of books dealing with nature study in Great Britain. They are of all sorts and sizes; but their general level is high, and in none of them more so than in the volumes of Collins's "New Naturalist Series". The list of titles here is now impressive; but that there are springs still unexhausted is well shown by two recent (though long adumbrated) additions to it, "Wild Flowers" by John Gilmour and Max Walters (No. 5) and "Mushrooms and Toadstools" by John Ramsbottom (No. 7), both of which fully maintain the standard set by their predecessors. The former is, essentially, a rather new treatment of a theme which never seems to tire, and perhaps the best compliment that can be paid to its authors, who write most pleasantly, is to say that they have succeeded in making something of their own that is distinctive. Incidentally, it should be noted with reference to p. 29 that ancient *Nelumbo* fruits from Manchuria were germinated in Britain almost thirty years ago (see *J. Bot.*, 1926). The latter book is, as essentially, a rich mine of information, both scientific and curious, about a narrower field, which, like some of the plants it contains, is something of an acquired taste, and here again the author has succeeded admirably in his task.

Indeed, if criticism is called for at all it is to be directed, in both cases, at matters of policy rather than content. "Wild Flowers" makes necessary, yet again, the strictures which have so often been passed on the inappropriate use of colour photographs in books of this kind. Surely so reputable a book should not suggest to the botanical tyro that birds-foot trefoil (Plate 12*b*) has large entire leaves, or that betony (Plate 2*b*), which is one of the strongest-hued plants in the flora, is one of the least convincing. All this, moreover, amid some very lovely black-and-white pictures. In "Mushrooms and Toadstools", where the subject eminently suits them, colour photographs are a success, and indeed may steal more of the author's thunder than they warrant; but here an unnecessary weakness is the inclusion of a chapter on penicillin, which, though vastly interesting, does not fall within the title of the book, and seems to have been put in more to tickle the public fancy than for any better reason. Nevertheless, both these books are notable additions to the literature of our country-side and remind us, once again, of the real truth in Stephen Leacock's words:

> "Surely no nobler theme the poet chants
> Than the soft science of the blooming plants".

RONALD GOOD

CHEMICAL ANALYSIS OF INDUSTRIAL SOLVENTS

Chemical Analysis of Industrial Solvents

By Dr. Morris B. Jacobs and Dr. Leopold Scheflan. (Chemical Analysis Series, Vol. 7.) Pp. xxii + 501. (New York and London: Interscience Publishers, Inc., 1953.) 10 dollars.

THIS book, the seventh volume in a series on chemical analysis, is a collection of methods used in the examination of solvents. The text can be divided into four sections: sampling and general physical and chemical methods; physiological effects of solvents and vapours; methods for the analysis of solvent mixtures; and the testing and determination of solvents in specific groups.

The general methods are comprehensive and include details of the determinations of specific gravity, viscosity, flash point, boiling range, acidity and iodine value, to name a few at random. The authors

have drawn the description of the testing equipment and many details of experimental methods from current American specifications, and not all the tests described can be applied to meet specifications accepted in Great Britain. The section dealing with the determination of *p*H is perhaps unnecessarily sketchy and curtailed, and this criticism can be applied to most of the physico-chemical methods described in later chapters—polarographic methods, for example, being dismissed in one page.

The chapters dealing with the analysis of solvent mixtures cover both the chemical examination of the liquid solvents and the absorption and examination of solvent vapours. Several schemes are given for chemical identification, and a section on the determination of functional groups is included. One feels that ultra-violet and infra-red spectroscopic methods should merit inclusion in this section, since both can be very useful tools in the analysis of mixtures.

The remaining two-thirds of the book is occupied by detailed analytical procedures for specific groups of solvents. Included are aliphatic, aromatic and cyclic hydrocarbons, alcohols and polyhydroxy compounds, esters, acids, aldehydes and ketones, and solvents containing nitrogen and sulphur. Methods suitable to the general group of solvents, again mainly drawn from specifications, and detailed procedures for the determination of individual solvents are described. The use of trade names for reagents is sometimes confusing, and a mistake appears in the tests for acetic anhydride and formic acid. The general layout and binding are excellent, and the contents list and index satisfactory. References in the text are numerous, and an additional list of selected references is to be found at the end of each chapter.

The book is a most valuable addition to the library of all analytical chemists, and all concerned with the varnish and lacquer industries will find it particularly useful as a book of reference.

C. Whalley

WHAT IS KNOWN ABOUT SLEEP

Sleep

How to Get More of It. By Chapman Pincher. Pp. 120. (London: "Daily Express", 1954.) 5*s*.

THIS little volume will probably be added to the 3,500 titles currently listed in "How-to-Do-It Books: A Selected Guide"—books that are intended to instruct the reader in "how to do, be, become, make, or cope with something". However, in this sense, the title of Mr. Pincher's book is misleading, as it contains nothing to suggest that *more* sleep is desirable, or how to get it. Quite to the contrary, there is a chapter on "How to Stay Awake".

The eighty-odd pages of text, divided into seventeen chapters, each preceded by an appropriate humorous drawing, represent a fairly accurate digest of findings in research laboratories and hospitals, culled from "day-to-day study of technical reports from many countries". Interspersed historical and contemporary anecdotes pertaining to sleep, as well as accounts of the author's own varied experiences, in war and peace, serve to enliven an otherwise dry recital of scientific and medical discoveries. Mr. Pincher's interpretations of the latter are, unfortunately, not altogether free from contradiction and one-sidedness. Thus, in Chap. 1 ("Settling Down to Sleep"), he chooses to "plump for the side-lying posture put forward recently as most satisfactory by Dr. James McDonnell, a London physician", using three drawings to illustrate the one proper and two faulty positions. Nevertheless, he admits, in the same chapter, that "no matter what posture you adopt for going to sleep however you are certain to change your position many times during the night". Evidently it makes little difference whether one goes to sleep in one position or another. Yet Mr. Pincher states that when he directed attention to Dr. McDonnell's recommendation in a newspaper, several readers wrote to him "gratefully because the information had brought them more restful sleep than they had enjoyed for years".

The author rightly rejects the old 'anæmia theory' of sleep; but, on the basis of a reported lowering of the degree of oxygen saturation of hæmoglobin, surmises that "the brain as well as the rest of the body is subjected to some degree of oxygen starvation during sleep" (p. 25). He further declares that "there is no doubt that the blood-supply to the brain is considerably reduced during sleep" (p. 41). As a matter of fact, the brain consumes just as much oxygen during sleep as in wakefulness (about 3·5 ml./100 gm./min.), and, as to blood flow, it is actually *increased* some 10 per cent (from 59 to 65 ml./100 gm./min.) in sleep, due to the dilatation of the cerebral blood-vessels.

Mr. Pincher abandons his role of mere interpreter of technical reports when, in Chap. 11, he propounds a theory of antidromic conduction from the visual area of the cerebral cortex back to the retina as an explanation of hallucinations. That a *psychological* projection from the brain to the visual field is involved in normal vision of real objects was convincingly demonstrated by Christoph Scheiner in 1614. A hallucination, therefore, or seeing things that are not actually there, can result from cortical stimulation (chemical, electrical, or other) that originates locally, instead of in the outside world, via a retinal image. It should be admitted, however, that the general reader will not comprehend, and so will not be harmed by, the author's excursions into the realm of oxygen starvation or theory of hallucinations.

The book also deals with the physiology of wakefulness and the diurnal variation in alertness. Many a reader will rid himself of a guilt complex on learning that Mr. Pincher found what he "had been seeking for thirty years—a medical reason for getting up late in the morning and going to bed late at night" (p. 32). Other topics touched upon are: dreaming, snoring, insomnia, sleep in animals and babies. Concerning the latter, it is not true that new-born babies sleep "most of the twenty-four hours", and that sleep is reduced to eighteen hours at three months and to seventeen hours at six months (p. 101). Recently published figures show that the average baby sleeps only about fifteen hours at birth and less than fourteen hours at the age of six months.

Summing up: when he is not venturing beyond his eruditional depth, Mr. Pincher does an excellent job of popularizing science. Disregarding the 'howtoism' of its title, and considering the universal interest in the subject-matter, the book will be found both instructive and entertaining. It can be recommended to the non-scientific reader as one of the better written accounts of the nature of sleep and wakefulness.

N. Kleitman

RICE SUBSTITUTES

By V. SUBRAHMANYAN, D. S. BHATIA, M. SWAMINATHAN and G. S. BAINS
Central Food Technological Research Institute, Mysore

DURING the past few decades, there has been a steady deterioration in the overall food position of many of the east and south-east Asian countries. The total production, chiefly of food-grains, has undoubtedly increased; but the demand from the rapidly growing population has increased to a greater extent. As the result of this, countries like India have steadily changed from the position of exporters to that of importers of food-grains. The population of India has been increasing at an average of 1·35 per cent[1] a year and that corresponds to about 4·5 million a year, at the present time, with the prospect of increasing to a higher figure in the years to come. A large section of the population are rice-eaters, and as this grain is in great demand, the prices have been steadily rising, though, during 1953, owing to an exceptionally favourable season throughout the region, the export price from surplus countries like Burma came down from about £80 to about £60 per ton. It may be reasonably expected that the price will tend to rise again. Unless the consumers change to other types of food-grains, there may even be a rice famine in the years to come.

As a bulk food material, rice has certain unique properties, which are not shared by other food-grains. It has a neutral taste and flavour and can be consumed as a savoury or a sweet dish. It is easily cooked and digested. Having become accustomed to such a soft and almost fibreless grain, the average rice-eater will not readily change over to any other food material which does not possess similar properties. In fact, attempts made in India to popularize wheat, jowar or maize among rice-eaters have not been successful. Provision of a substitute for rice has therefore become one of the major food problems not only for India but also for the whole Asian rice region, which holds more than half the population of the world.

Processing of Grains and Tubers

One of the earlier attempts in the field was that of Bhatnagar, who carried out investigations on the reconstitution of broken rice, as obtained during milling, into whole rice. During recent years, attempts have been made to process other grains so as to give them the shape and cooking quality of rice. Thus, wheat, barley and maize have been processed, and some brands like 'Rycena', 'Barley-rice' and 'Nor-ice' are already on the market. During the war years, wheat semolina was processed to produce different brands of 'mock rice'. Potato rice is still being produced in Holland. Such rice substitutes require the appropriate starting materials, which are not themselves being produced in sufficient quantities in the south-east Asian countries. If the deficit countries are to meet their own requirements, alternative sources, which can be plentifully and cheaply produced in the same region, will have to be found.

Processing of Blends

Since 1949, the Central Food Technological Research Institute, Mysore, has been engaged on the study of the possible utilization of cheap and abundant food materials which are naturally rich in starch and protein, so as to obtain, by suitable blending, a composition and nutritive value approximating to that of rice. After trying hundreds of such blends, it was found that a combination of tapioca (*Manihot utilissima*) and groundnut flours would make a cheap and satisfactory blend. *Manihot* grows well on even comparatively poor soils, and the yield of root, on a dry basis, is at least 3–4 times as much per acre as in the form of any food-grain. When both the outer skin and the inner rind are removed, the residue, on drying, yields an attractive white flour which, though mostly starchy, still contains useful quantities of minerals, especially calcium. Goundnuts can be skinned after gentle roasting or other treatment. The oil can be mostly removed by the expeller or solvent extraction. The residue yields a pale yellow, attractive flour containing about eight times as much protein as milled rice. If the groundnut kernels are carefully selected, the flour keeps well for several months. Both tapioca and groundnut flours, between them, contain more of the essential minerals and vitamins than natural rice. By combining tapioca and groundnut flours in the proportion 85 : 15, a product with an overall nutritive value which was somewhat higher than that of rice was obtained.

The technological aspects of converting such a blend into a grain like rice offered the maximum difficulty. Like other root starches, tapioca starch tends to cook to a translucent and sticky mass. Groundnut protein, especially as present in the flour, has no binding power. It was found, however, that on treatment with 40–50 per cent by weight of boiling water, the starch in the mixture (chiefly that of tapioca) becomes sufficiently gelatinized to yield a satisfactory dough. The dough could be extruded under pressure; but as the resulting product did not possess good cooking properties, further improvements in the composition had to be made. It was found that the addition of 1·5 per cent of karaya gum (*Sterculia urens* Roxb.) improved the quality of the dough and generally the body of the cooked product. Further improvement was introduced by the addition of 1 per cent alkali-digested corn cob. This material tended to harden the grain. Addition of 0·3 per cent of stearic acid made the grain somewhat opalescent and improved its individuality. The colour of the finished product was distinctly improved by the incorporation of 0·04 per cent alkali bisulphite. All the above-mentioned products may be added together as a mixture at the time of the preparation of the dough. The resulting grain, as obtained through an extruding press fitted with the rice die, was quite attractive and comparable in appearance with that of certain brands of natural rice. The product required, however, certain further improvements so as to make it acceptable to the consumers.

In India, as also in most other parts of Asia, the average housewife washes the rice before cooking because the usual bazaar product contains much dust and dirt. Like the usual macaroni products, the extruded grain as prepared above tended to break

Table 1. Comparative Chemical Composition (per cent) of some of the Rice Substitutes as compared with that of Natural Rice

	Natural rice[a]	'Rycena'[b]	Mock rice[c]	Pearled barley[b] (barley rice)	Japanese 'synthetic rice'[d]		Mysore (Indian) 'synthetic rice'[d]
					A	*B*	
Moisture	13·0	8·2	14·0	10·08	14·0	14·0	9·5
Protein ($N \times 6{\cdot}25$)	6·9	10·7	10·7	9·85	3·7	7·0	14·2
Fat	0·4	1·6	1·8	1·88	0·3	0·5	1·9
Carbohydrates	79·2*	69·3†	77·5	69·0†	81·1*	77·4*	71·7
Fibre	—	—	—	—	0·3	0·4	0·7
Ash	0·5	1·22	—	1·35	0·6	0·7	2·0
Calcium (as Ca)	0·01	0·05	0·018	0·036	—	—	0·19
Phosphorus (as P)	0·11	0·24	0·114	0·20	—	—	0·15
Thiamine (mgm.)	0·06	0·19	—	0·02	—	—	0·22
Calorific value per 100 gm.	348	343	352	340	344	343	361

[a] Health Bulletin No. 23 (Govt. of India, 1951).
[b] From pamphlet issued by Rycena Food Products Pty., Ltd., Melbourne.
[c] Same as semolina (M.R.C. Report, Series No. 235, 1946), "Chemical Composition of Foods" (H.M.S.O., London).
[d] *Rice Journal*, **57**, 20–22 (February 1954) (synthetic rice *A* is made up of potato starch 50%, wheat flour 40%, rice flour 10%; and synthetic rice *B* of potato starch 20%, wheat flour 70% and rice flour 10%).

* Calculated by difference. † As starch. — Indicates figures not available.

up on being washed and rubbed with cold water. On cooking, it was found that there was heavy gruel loss which, again, would not be acceptable to consumers. The cooked grain was also a little too soft to the bite. It was necessary, therefore, to introduce further improvements in the processing. It was found that, on heating to a temperature of 110–120° C. for even a few minutes, the starch of the blend, and particularly that of tapioca, changed in character and that the individuality of the cooked grains was fairly well preserved. Gruel loss was also reduced to a minimum. Further improvement was effected by spraying a thin coat of calcium caseinate (calcium oxide : casein = 1 : 20) on the finished grain. Even a thin coat corresponding to 3–4 per cent by weight made the grains fairly resistant to water. They could be washed and rubbed under water for 4–5 min. without any appreciable loss. The coat also improved the cooking quality, and the cooked grain had a feel and taste corresponding to that of slightly parboiled rice. It was also found that incorporation of wheat flour to the extent of 20 per cent greatly improved the quality of the dough and the finished grain. In fact, the use of chemical improvers can be largely dispensed with if some wheat flour can be incorporated in the mixture.

Factory Trials

With the above as the background, factory trials were carried out in the United Kingdom and later in Switzerland. Messrs. Buhler Brothers, of Uzwil, took a keen interest in the effort, and fabricated the necessary additional equipment for large-scale processing. The procedure which was finally followed consisted in feeding the flour blend through the conveyor and then running boiling water in a steady stream into the mixing and kneading tank. The resulting dough was then drawn into the extruding press, where it was forced under pressure through a rice die provided with the usual mechanical cutter. The grain which came out, in a steady stream, was then subjected to a preliminary, and then a final, drying. As the grain does not crack on heating, it was found that the temperature could be readily raised to about 120° C., so that the drying could be speeded up. The same heating chamber also served to condition the grain so that both the operations were combined in one. In semi-large-scale operation, heating for about 2 hr. at 120° C., combined with air circulation, serve to dry the grain and at the same time to condition it. The finished grain thus obtained was subjected to spraying with a thin suspension of calcium caseinate, steamed and then dried in a blast of hot air. This helped to dry off the coat almost as quickly as it was formed and thus discouraged the tendency to form lumps. Mechanical agitation during spraying was necessary.

Properties and Nutritive Value

The finished grain, thus obtained, has the appearance of slightly undermilled rice. It is best cooked by being dropped into boiling water, and the cooking time is 5–6 min. as compared with about 20 min. required by raw, milled rice. The cooked product has the taste corresponding to that of certain brands of rice, as sold in the Indian market. Consumer trials have shown that the product is acceptable to rice-eaters.

Animal experiments with the product showed that the overall growth-promoting value is more than twice that of a good variety of rice. The product has been given the name 'synthetic rice', in keeping with the name 'synthetic diet' which is used by nutrition workers for blended diets composed of the various food ingredients.

The raw materials, including all the accessories, would cost the equivalent of about Rs. 350 per ton. The entire processing cost, including labour, supervision and depreciation, would amount to Rs. 50–60 per ton. In the early stages, the cost would naturally be high; but with the continued working and on a big scale, it would eventually come down. Allowing for incidentals, the product can be marketed at about Rs. 500 (less than £40 or 100 dollars) per ton. Even at this price, it would be distinctly cheaper than rice. With further experience, and on continued large-scale production, the cost can be further reduced.

The potentialities of such a product can be easily envisaged. With a given area of land, and with much less attention, we can obtain 3–4 times as much of the starting materials as can be obtained in the form of any food-grain. This will be of great advantage to the densely peopled countries, with heavy pressure on land. The second, and a more important, feature is the nutritive value. The product, as prepared by the Mysore workers, has about twice the nutritive value of rice; but it can be stepped up to a still higher level if so desired. Considering the low level of nutrition in most of the tropical countries, and especially in the rice-eating region, there is a very strong case for using synthetic rice either by itself or as a supplement in the dietary of the people.

Japanese Production

The researches conducted at Mysore have been published[3–10] in the form of short notes and papers which have appeared during the past three years. Numerous popular articles and pamphlets have also been published. During 1952, the Japanese manufacturers, who have also been keen on the search for rice substitutes, started production, using blends of potato starch, wheat flour and rice flour for their composition. The underlying principles are practically the same as those of the process adopted by the Mysore workers. The Japanese have also adopted the same English name, 'synthetic rice', for their product, and the Japanese name is 'zin-zomai'. It should be said to the credit of the Japanese that they were quick in taking up the manufacture. During 1952–53, the reported production is stated to have been about 100,000 tons. The price of the Japanese product appears to be fairly high; but there is no doubt that it will eventually be reduced. Further improvement in nutritive value is needed, and this can be achieved by adding a concentrated proteinaceous material along the lines indicated by the Mysore workers.

The relative chemical compositions of some of the rice substitutes as compared with natural rice is given in Table 1.

Outlook for the Future

Judging from the present trends, there is every indication that the rice production in the east and south-east Asian countries will not be able to cope with the increasing demands of the fast-growing population. A product like synthetic rice is bound to find a growing demand, and in the course of the next few years we may reasonably expect to see the production rise to a few million tons per annum. With further improvements in the composition and the technology of processing, better and cheaper grains could be produced. The nutritive values of the products can also be maintained at a distinctly higher level than that of natural rice.

There are already a number of rice substitutes on the world's market. They are made from different raw materials and they have varied compositions. Most of them are being marketed under proprietary names and selling on their own merits. It is expected that, in course of time, several more such products will be marketed. It will soon be necessary to discuss the composition of such products and to lay down specifications on an international basis; the Food and Agriculture Organization can usefully take the initiative in this direction.

There are three broad lines of food production. The first one is that of increasing the production from land, water and other sources. Improved methods can easily raise the world's production by 25 or even 50 per cent, though it will be extremely difficult to ensure a uniform application of such methods all over the world. The second method is that of converting the vast and abundant sources of second-grade food materials, by suitable blending, into first-class articles of food. Production of synthetic rice will come in this category. Products like sugar from cellulose, food yeast, food-stuffs from seaweeds and other algae will also come in the same category. The possibilities in this direction are very considerable. The third method, which is still a dream of chemists, is that of synthesis from elementary materials. Unlike the fixation of nitrogen, the fixation of atmospheric carbon dioxide is going to be rather difficult because of the low concentration of this gas in the atmosphere. For a long time to come, the world may have to depend on the processing of coarse and low-grade food materials, which are fortunately still abundant, and their conversion into first-grade articles of food. Production of synthetic rice is a beginning in this direction; but bigger and more important developments are bound to follow in the years to come.

[1] Cent. Food Tech. Res. Inst., Mysore (Pub.), "Food and Population" and "Development of Food Industries", pp. 357, illus. (Mysore, 1952).

[2] Subrahmanyan, V., Rama Rao, G., and Swaminathan, M., *J. Sci. Indust. Res.*, B, **9**, 259 (1950).

[3] Bhatia, D. S., *Indian Coffee*, **16** (1), 6 (1952).

[4] Subrahmanyan, V., *Bull. Cent. Food Technol. Res. Inst.*, **2**, 48 (1952).

[5] Subba Rao, G. N., Bains, G. S., Bhatia, D. S., and Subrahmanyan, V., *Trans. Amer. Assoc. Cereal Chem.*, 11 (2), 167 (1953).

[6] Subrahmanyan, V., *Bull. Cent. Food Technol. Res. Inst.*, **2**, 239 (1953).

[7] Subrahmanyan, V., Bhatia, D. S., Bains, G. S., Swaminathan, M., and Raghunatha Rao, Y. K., *Bull. Cent. Food Technol. Res. Inst.* (in the press).

[8] Bains, G. S., Bhatia, D. S., Subba Rao, G. N., and Subrahmanyan, V., *ibid.* (in the press).

[9] Subrahmanyan, V., Kuppuswamy, S., Rama Rao, G., Swaminathan, M., and Bhatia, D. S., *ibid.* (in the press).

[10] Subrahmanyan, V., Kuppuswamy, S., Rama Rao, G., Swaminathan, M., and Bhatia, D. S., *ibid.* (in the press).

RHEOLOGY IN MECHANICAL ENGINEERING

RHEOLOGY is regarded by some as a specialized activity concerned with the description of the response to mechanical stress of those categories of matter the behaviour of which cannot, even approximately, be described as Newtonian flow or Hookean deformation. Others view the subject more broadly as that branch of the science of applied mechanics which is concerned with the deformation and flow of matter generally. The membership of the British Society of Rheology embraces both those who specialize in the subject and those chemists, physicists and engineers, mainly engaged in applied science, whose work involves a knowledge of deformation or flow of matter and who find in the Society common ground for the development of this interest. It is to these latter that the recent conference of the Society held at the Mechanical Engineering Research Laboratory (Department of Scientific and Industrial Research), East Kilbride, during June 10–12 will have had the most appeal.

This Laboratory, which has assumed responsibility for a large part of the research formerly pursued in the Engineering Division of the National Physical Laboratory, is organized in seven divisions as follows: properties and strength of materials; mechanics of solids, stress analysis and vibration; mechanics of fluids, including hydraulic machinery; lubrication, wear and corrosion; mechanisms and engineering metrology; mechanics of formation and machine shaping of materials; heat transfer and applied thermodynamics. It will be apparent from this list of activities that the deformation and flow of matter enters very much into the work of the Laboratory, and the opportunity afforded to participants to inspect work in progress was a valuable feature of the conference.

In view of the importance of metals as materials of construction for machinery, it is not surprising that the predominant interest in the conference was the

flow of metals. Thus the first paper, by Dr. J. F. W. Bishop (East Kilbride), was on the relationship of certain properties of metals to their crystal structure. Phenomena associated with metals were divided into three classes—macroscopic, microscopic and atomic—and the relevance of investigations at one of these levels to phenomena associated with a different level was discussed. Dr. Bishop summarized the salient features of three types of lattice structure commonly occurring in metal crystals and described their mechanism of deformation, stressing those structures which are able to accommodate an arbitrary strain by relative sliding of atomic planes. Applications of the Bishop–Hill theory of crystal distortion as generalized for aggregates were described and discussed in relation to experimental evidence.

Mr. H. Ll. D. Pugh (East Kilbride), in his paper on current problems and experiments on time-independent plastic deformation, dealt with the fundamental plastic properties of materials, such as yielding under combined stress, hardening and the effects of hydrostatic pressure. In the absence of a general solution of the equations governing plastic flow, their simplification for the special cases of plane stress and plane strain is necessary to enable certain engineering problems to be attacked. Strip drawing, extrusion and certain machining operations resolve themselves into steady-state problems, while indentation becomes a yield stress problem. Theoretical and experimental results were compared for extrusion and for indentation with flat smooth rigid dies.

Mr. F. Ellis and Prof. H. Ford (Imperial College of Science and Technology, London) discussed strip rolling as a steady-state process. An approximate theory was outlined by Prof. Ford, who described subsidiary experiments to determine the yield stress–strain characteristics of the strip material. Coefficient of friction between roll and work was estimated from rolling experiments in which varying amounts of back tension had been applied. Mr. Ellis described experiments wherein the data required to plot the slip-line field were obtained from the measured distortion of a network of lines engraved on a surface lying in the plane of flow. This technique was complicated in its application to rolling by forces in the plane of the sheet which would cause two unattached sheets placed side by side to separate. The difficulty was overcome by a specially developed method whereby the edges of two sheets could be welded together after the reference lines had been engraved on them.

In contradistinction to the two previous contributions, which were directed towards the elucidation of situations wherein it was desired to cause flow as part of a manufacturing process, that by Dr. A. E. Johnson (East Kilbride) on the behaviour of metals under complex stress at high temperatures was concerned with the small unintentional flow or creep of metals used for the construction of boilers, turbines, etc., that are required to operate at high temperatures. Where such parts are subject to combined stresses, designers have previously been obliged to rely on experimental data obtained from simple stress tests and adjusted by doubtfully valid theory. Dr. Johnson described a comprehensive research into the complex stress, creep, plastic strain and relaxation properties of some typical technical materials. At lower stresses the materials were shown to follow the St. Venant–Von Mises creep-rate relations and to remain isotropic; but at higher stresses the strained material becomes anisotropic, which necessitates modification of the equations.

Fatigue failure of metals may be regarded as a rupture rather than a flow phenomenon, but some work sponsored by the Mechanical Engineering Research Laboratory and described by Mr. N. Wadsworth (University of Bristol), in a paper on observations on energy dissipation during high-speed fatigue tests, revealed the occurrence of an increasing number of slip bands during the progress of a fatigue test. During the early stages of a test, the rate of energy dissipation in the material fell to a low value and then increased until failure occurred. This increase was dependent on stress, and a strong correlation between this rate and fatigue life was revealed. Annealing at intervals during the test appeared to remove the effects of previous stressing on energy dissipation, but did not affect life. This threw doubt on the significance of the observed correlation, and Mr. Wadsworth concluded with the suggestion that the first irreversible change leading to the formation of cracks must have occurred very early in the fatigue test.

A more general approach to rheological problems was represented by a contribution from Dr. P. Feltham (Standard Telecommunication Laboratories) on the laws of stress relaxation and creep in solids. Remarking on the qualitative similarity in the response of solids of widely different structures to applied stresses, particularly in creep and relaxation, Dr. Feltham sought an explanation in the nature of flow itself rather than in the study of detailed atomic or molecular structure. A given solid can be assumed to possess 'relaxation centres' having approximately the same heat of activation but, on account of variations such as shape and size, having different configurational entropies of activation. Assuming normal distribution of relaxation times it is possible to derive a relaxation curve common to many solids. Experimental data selected from published work relating to aluminium, rubber, plastics and ceramics were shown to be in good agreement with the theory. Dr. Feltham regards Nutting's Law as approximating to more general laws over sufficiently wide ranges of the variables to be of practical use in the presentation of experimental data.

The fact that mechanical engineering science is by no means confined to the behaviour of solids was exemplified by a paper by Mr. E. J. Le Fevre (East Kilbride) which dealt with some developments in the theory of viscosity. The importance of the viscosity of gases in the study of the transfer of heat by convection is obvious; but availability of experimental data covering this quantity over the range required is restricted, and discrimination is necessary in assessing its accuracy. Mr. Le Fevre showed how viscosity data relating to those fluids which satisfy the principle of corresponding states can be correlated in terms of reduced variables. It was shown that, with few exceptions, the viscosity of gases can be predicted within about 5 per cent from knowledge of the three critical constants. This result was considered relative to the kinetic theory and was shown to be deducible from combination of the Lennard-Jones and Devonshire theory of the critical state with the calculations of Kihara and Kotini. The Sutherland model was shown to be inconsistent with experiment.

Many problems of fluid motion in the mechanical and chemical engineering industries are amenable to solution by models, and Mr. W. J. Robinson (East Kilbride), in his paper on some fluid-motion problems, exemplified useful applications of this technique at the Mechanical Engineering Research Laboratory. Advantages are offered by substitution in a model of

gases for liquids or vice versa. The conflicting requirements of the laws of similitude complicate the design of experiments, and a plea was made for the publication of more experimental data to provide a basis for evolution of rules to govern the 'scaling-up' of model performance. Increases in the duty required to be undertaken by modern hydraulic machinery have caused a marked increase in the incidence of cavitation, and Mr. Robinson discussed the influence of the properties of the liquid itself and the presence of nuclei on cavity collapse and noise. Methods for estimating flow losses with non-Newtonian liquids require development. The pumping of raw peat and measurement of the flow of blood to and from the human heart provoked a lively discussion.

Lubrication has been defined as the reduction of friction and wear between rubbing surfaces by interpolation of substances which offer resistance to the normal forces pressing the surfaces into contact and yet are capable of being deformed easily in a tangential direction. It is obvious that the rheological properties of lubricants are of interest to engineers concerned with running machinery, and Dr. F. T. Barwell (East Kilbride), in a contribution on lubrication from the rheological point of view, outlined some of the considerations governing boundary and hydrodynamic lubrication. Further understanding of the mechanism of wear is dependent, among other things, on an understanding of the rheological behaviour of material in the surface regions of components suffering damage. Examples were given of those forms of wear known as abrasion, scuffing and pitting, and the potentialities of radioactive tracer methods for the study of wear were discussed.

THE ROYAL NETHERLANDS METEOROLOGICAL INSTITUTE (1854–1954)

THIS decade is one of centenaries in the meteorological world, for official meteorological activities started in many countries around 1850. The Royal Netherlands Meteorological Institute, now at De Bilt near the town of Utrecht, was established in 1854 and celebrated its centenary this year on January 31. As part of the celebrations, a substantial memorial volume has been prepared*, in which the history of the Institute is portrayed in word and image.

Meteorology in the Netherlands did not start in 1854; there are many signs of earlier activity in the form of long series of observations, admirably compiled by Labrijn. As everywhere else in the world, these observations were made at universities, or by organizations and persons especially interested in meteorology; and looking at the state of affairs in 1854, one should realize that the famous American naval officer, Maury, prior to that year, had already collected many meteorological observations from oceanic areas.

In the Netherlands it was important for the development of the subject that Buys Ballot, chemist, mineralogist, mathematician and physicist, became fascinated by meteorological problems, and that he, in his position as university professor, created an observatory in Utrecht. Late in 1853 Buys Ballot convinced the Government that "there was a future in the establishment of a Meteorological Institute" and early in 1854 his observatory was converted into the Koninklijk Nederlands Meteorologisch Instituut. Buys Ballot was the first director of the Institute and aimed very high. Translated freely, his programme was formulated by the words: "As a result of the methods we have adopted—namely, to collect observations from some well-selected points abroad and to study the deviations from the normals at these points—the Institute pursues a higher object than any other existing institute. Day after day it deals with the most important questions in meteorology, the solution of which was already some years ago vaguely indicated by Dove for monthly periods. Utrecht will become the central observatory for Europe. Already nowadays the weather and its changes over the greater part of Western Europe are being closely followed and studied".

The early period of Buys Ballot's directorship was one of great activity. It was the time of Dove in Germany, Espy in the United States, FitzRoy in Britain and LeVerrier in France. It was also the time in which meteorologists suddenly became aware that weather forecasting might develop into a reality as a result of the invention of the electric telegraph. Great discoveries were made: Buys Ballot announced one of them in the form of four propositions during a meeting of the Netherlands Academy of Sciences (October 3, 1857), and it was on the basis of these four propositions that later on the famous wind law of Buys Ballot was formulated. Weather maps, though rather primitive, were drawn by Buys Ballot on a routine basis, and a gale warning service was established in 1864. Internationally minded as he was, Buys Ballot copied the system of signals already in use in Britain; but when the British service was discontinued in 1866, he felt free to develop the 'aëroclinoscope', a new design to indicate forthcoming gales to sailors. The aëroclinoscope was a signal post, which showed the direction and value of the pressure gradient over the Netherlands. Its indications had therefore to be interpreted by the users, who had to have a thorough idea of Buys Ballot's law. This might be one of the reasons why the Dutch merchant marine became so early thoroughly interested in meteorology and assisted the Institute in building up an enormous amount of material, gathered from almost every ocean.

It is worth noting that Buys Ballot needed continuous registration of the pressure values at several stations in order to be able to follow the gradients closely. The first electric telerecorders, precursors of our radiosondes, were then developed and for some time serious efforts were made to record at Utrecht the pressure values at Flushing during the night hours. The technical difficulties appeared to be very great, and finally the efforts were given up. It is still, however, customary in the Dutch synoptic service to compute the pressure gradient in various triangles over the Netherlands on an hourly routine basis.

Buys Ballot needed uniform observations for the successful realization of his programme. The well-known international congress in Brussels (1853), which was initiated by Maury, created a certain uniformity in maritime meteorology; over land, however, observations were made at different times, with different instruments in varying exposure. The difficulties resulting from the lack of generally

* Koninklijk Nederlands Meteorologisch Instituut 1854–1954. Pp. 469+74 figs.+4 coloured plates. ('s-Gravenhage: Staatsdrukkerij en Uitgeversbedrijf, 1954.)

accepted rules inspired Buys Ballot to write a treatise entitled "Prière à tous ceux qui veulent bien de la météorologie" (1856). But it was only sixteen years later that Buys Ballot opened the first international meteorological congress at Leipzig and became the first president of the International Meteorological Committee and the real father of international meteorology. Dutch meteorologists continued to play important parts in the international meteorological world; Van Everdingen guided the International Meteorological Organization during 1923–35, and Cannegieter was the first chief of the permanent secretariat of that Organization.

The Institute lost its great leader in 1890, and with his decease an era of steady development came to an end. Meteorology entered, not only in the Netherlands but also elsewhere, a rather dull period which started with "the disappointment of the nineties". New horizons were opened around 1910, with the beginning of upper-air observations. Van Everdingen, director since 1905, started his activities as extra-ordinary professor at the University of Utrecht with a lecture entitled "The Third Dimension in Meteorology". A theodolite for recording the projections of pilot balloon-tracks was developed, kite ascents were made, and many Dutch meteorologists had licences as free-balloon pilots. Cannegieter was the first who experimented with aeroplanes as meteorograph-carriers, and the regularity of the Netherlands upper-air ascents became known all over the world. When a new field was opened with the introduction of the radiosonde, Cannegieter used the instrument on an expedition to the Azores, from where no upper-air information had previously been obtained, and also in Iceland during the second Polar Year.

When Van Everdingen took the reins, the Institute, which had moved from Utrecht to De Bilt in 1897, consisted already of five divisions. It was then, and still is, really a geophysical institute, the activities of which are not limited solely to meteorology. With the development of the geophysical sciences during the course of the past half-century, the divisions slightly changed their names, but there are still those of forecasting (now combined with aeronautical meteorology), climatology (now combined with agricultural meteorology), maritime meteorology (now combined with oceanography), seismology and magnetism (now also deeply involved in ionospheric research) and finally a general service division (administration, library, workshop and instrument development). Each division is headed by a director (a specialist in his own field), and in Van Everdingen's time the director in chief was still an all-round meteorologist.

Cannegieter guided the Institute through the unhappy period of the Second World War, when forecasting for the general public and for aeronautics was curtailed, and synoptic and aerological observations were totally stopped. In spite of all material and other difficulties, the war period provided some dividends, as the synoptic staff took part in an extensive magnetic survey of the Netherlands, thorough plans could be made for future development and serious scientific investigations improved the knowledge of the forecasters who were perforce idle during this period.

Thus came the post-war period, with its stormy development in the Institute's activities and the enlargement of its field of action. Cannegieter, who had already passed the retiring age, was succeeded by Vening Meinesz, a geophysicist of renown who had already long relations with the Institute, where, among others, his apparatus for gravity measurements at sea had been built. From 89 men (24 scientists) in 1945 the personnel jumped to 345 (73 scientists) in 1954. The greatest growth took place between 1945 and 1950. It was no longer feasible to house all the workers stationed at De Bilt in the old building. Offices were spread all over the village. The disadvantages of this involuntary decentralization were felt almost daily. Vening Meinesz's ambitions to bring the Institute again under one roof were, in spite of all difficulties, realized in 1953, when new wings to the old building came into use. The floor space of approximately 1,000 m.² was increased to 3,500 m.², and, in addition, a plot of 2 hectares was joined to the gardens, sufficiently large for investigations in the field of agricultural meteorology and for the launching of radiosondes in spite of the fact that the aerologists are close neighbours of the ionospheric transmitter with its high antennæ.

Vening Meinesz found himself too much absorbed in administrative duties and returned to science again in 1951, at the moment when, according to his views, the staff was sufficiently large to deal with its practical and scientific tasks, and when his plans for the extension of the premises were accepted by the Government. He was succeeded by the present director, C. J. Warners, a former Secretary of State in the Netherlands East Indies.

The Royal Netherlands Meteorological Institute is an entity in the economic life of the Netherlands, not only because of its forecasts for the general public, agriculture and horticulture, fisheries, shipping and aviation, but also because of its activities in so many other fields. It has relations with agricultural research, through an active group of agricultural meteorologists. With those interested in the water balance of earth and atmosphere, it studies evaporation and related processes. A group of statistical workers has already solved many practical problems. The maritime meteorologists, up to now engaged in the construction of the atlases for mariners, have diverted their interests in a scientific direction. Oceanographers pay much attention to high tides and storm surges in the North Sea, but do not neglect other problems of a local nature. New ideas about microseisms have developed in the seismology division, and the telegraph authorities keep close contact with the workers in the fields of magnetism and ionospheric research. These are but a selection of the many topics in which the Institute is interested, all of which are faithfully recorded in the recent centenary volume. W. Bleeker

OBITUARY

Mr. F. Morley Colebrook, O.B.E.

During his thirty-three years service on the scientific staff of the National Physical Laboratory, Mr. F. M. Colebrook, who died on June 21, played a major part in the development of the Radio Division from its birth as a section of the Electricity Division, and more recently became the head of the newly formed Electronics Section.

Colebrook was born in March 1893 and studied science at Birkbeck College, University of London. After service in the First World War, he continued his

studies at the City and Guilds Engineering College, obtaining his A.C.G.I. and B.Sc.(London) and, after some research on high-frequency resistance, his diploma of the Imperial College (D.I.C.).

He joined the National Physical Laboratory in 1921 and soon demonstrated his flair for carrying out a combined theoretical and experimental investigation of various fundamental problems in the radio field. He soon made distinctive, and very practical, contributions to our knowledge of the characteristics of transmitting and receiving aerials, to the development of radio-frequency valve amplifiers, the technique of the precise measurement of current and field-strength at high frequencies and the definition and measurement of interference. He was responsible for the publication of several special reports of the Radio Research Board, outstanding among which is the one entitled "A Theoretical and Experimental Investigation of High Selectivity Tone-Corrected Receiving Circuits". This work, published in 1932, did much to clear the minds of those responsible for the allocation of frequencies for broadcasting and communication services, at a time when confusion of thought made the 'physical reality of sidebands' a subject of serious discussion among certain authorities. Many other papers were contributed to the *Journal of the Institution of Electrical Engineers*, and to the *Wireless Engineer*, of which periodical he later became a member of the editorial advisory board. He was the author of two books on "Alternating Currents and Transients" and "Basic Mathematics for Radio Students".

On technical committees, as in his laboratory work, Colebrook displayed that outstanding characteristic for starting a penetrating inquiry into matters which had often already been accepted by others, and so bringing to light sometimes a fallacy, and at other times a new and refreshing point of view. As a colleague, he was delightful to work with, and he could be relied upon to produce a novel, if sometimes idealistic, point of view on any new problem; he was always ready to be consulted. I was indeed sorry when, with the formation of the Radio Research Organization, Colebrook was destined to sever his formal association with radio matters and become the leader of the separate team formed at the National Physical Laboratory to develop, into a practical working machine, the mathematician's conception of an automatic electronic computor.

Apart from his work, Colebrook was a man of many tastes. He read voraciously and widely, he had a keen ear for music, and with the aid of a high-fidelity receiver of his own design and construction, he seemed to listen to and enjoy every worthwhile musical broadcasting programme. He had a lively interest in amateur dramatics; he was a keen gardener, and, under the necessities of wartime, took a practical and utilitarian interest in the breeding of rabbits.

It is to be regretted that he was not spared to develop and enjoy these personal and unofficial activities, or even to be invested with the O.B.E., to which he was appointed in June last.

R. L. Smith-Rose

NEWS and VIEWS

Chemistry at the Imperial College of Science and Technology : Prof. H. V. A. Briscoe

After an association with the Imperial College of Science and Technology extending, with one intermission, over a period of forty-eight years, Prof. H. V. A. Briscoe now relinquishes the directorship of the laboratories for inorganic and physical chemistry at the College, and retires from his chair of inorganic chemistry in the University of London. Entering the College as a student in 1906, he served after graduation as research assistant to the late Sir Edward Thorpe and afterwards was a member of the teaching staff of the Chemistry Department. In 1921 he was appointed to the chair of inorganic and physical chemistry in Armstrong College (now King's College) at Newcastle upon Tyne, in the University of Durham, succeeding the late Sir Norman Haworth four years later as head of the Chemistry Department. In 1932, however, he returned to the Imperial College to follow Prof. H. B. Baker in the chair of inorganic chemistry, and on the retirement, four years later, of Prof. J. C. Philip, assumed the direction of the laboratories for inorganic and physical chemistry.

Throughout an active academic career Prof. Briscoe has also devoted much attention to researches of industrial importance; he was one of the founders of the Northern Coke Research Committee and has served as president of the Research Association of British Paint, Colour and Varnish Manufacturers. He has also participated in a study of the part played by dangerous dusts in the causation of silicosis and similar maladies. In recent years, Prof. Briscoe has taken much interest in the organization of training for laboratory service, and is now chairman of the National Joint Committee on Recruitment and Training of Science Laboratory Technicians.

Prof. R. M. Barrer

The chair of physical chemistry at the Imperial College of Science and Technology in the University of London, formerly occupied by the late Prof. J. C. Philip, has now been filled by the appointment of Prof. R. M. Barrer. A graduate of Canterbury University College, Christchurch, New Zealand, Prof. Barrer held an 1851 Exhibition Scholarship at Clare College, Cambridge, afterwards being appointed to a research fellowship. During 1939–46 he was head of the Chemistry Department at Bradford Technical College. In 1946 he left Bradford to take up an appointment as reader at Bedford College, University of London. Since 1949 he has occupied the chair of chemistry in the University of Aberdeen, where he has gathered around him an active school of research in physical chemistry, particularly in those branches of the subject concerned with adsorption, diffusion, and the physicochemical properties generally of permeable materials, especially zeolites.

Physiology at Queen Elizabeth College : Prof. J. A. C. Knox

Dr. Joseph Alan Cruden Knox has been appointed to the chair of physiology tenable at Queen Elizabeth College (University of London) in succession to Prof. J. Yudkin, who has become professor of nutrition in the College. Prof. Knox was born in 1911 and was educated at Aberdeen Grammar School and Glasgow

High School. He studied medicine in the University of Glasgow and graduated M.B., Ch.B., in 1935 and M.D., with honours, in 1948. In 1936 he was appointed demonstrator in histology in the Department of Physiology at Glasgow; and in the same year became assistant to the professor of physiology, the late Prof. E. P. Cathcart. He became lecturer in physiology in 1940, and four years later was appointed to a similar post at King's College, University of London, where he became senior lecturer in 1948 and adviser of studies to the Medical Faculty in 1953. Prof. Knox has published work on the effect of exercise upon the heart-rate, based upon very accurate methods of counting. During the Second World War he worked with Dr. D. P. Cuthbertson on the effect of analeptics on fatigue. More recently, he has been interested in the electro-physiology of isolated muscle and its response to denervation. He has had very wide teaching experience both in Glasgow and in London.

Philosophy at the University College of North Staffordshire: Prof. A. G. N. Flew

Mr. Antony Garrard Newton Flew, lecturer in philosophy in King's College, University of Aberdeen, has been appointed to the chair of philosophy in the University College of North Staffordshire in succession to Prof. W. B. Gallie. Prof. Flew was educated at Kingswood School, Bath, and was State Scholar in Japanese at the School of Oriental and African Studies in 1942, afterwards being attached to the Air Ministry in the Intelligence Section. He went to Oxford in 1946, taking a first in Greats in 1947, and was awarded the John Locke Scholarship in Mental Philosophy in 1948. He was then appointed lecturer in Christ Church, Oxford, before going to King's College, Aberdeen, in 1950. Prof. Flew has a considerable interest in adult education and has conducted many courses for the Workers' Educational Association and Service groups as well as broadcasting. His main studies lie in the notions of personal identity, survival and immortality, which have led him to a philosophical consideration of psycho-analysis and psychic phenomena. An enthusiastic mountaineer, Prof. Flew takes to his new post at North Staffordshire an energy and zeal which augur well for the rapidly developing school of philosophy in the College.

Development of Canada during the Past Few Decades

Addressing the Parliamentary and Scientific Committee on June 3, Dr. C. J. Mackenzie, president of the Atomic Energy Control Board, Canada, reviewed the fundamental political and economic changes which science and technology have made in Canada since 1918. He thinks that there is a substantial basis for Canada's prospects and prosperity. Since 1939, the population of Canada has increased from eleven to fifteen million, while the net income has doubled and government expenditure and foreign trade increased four-fold. Only 14 per cent of Canada's capital now comes from outside. Referring to the development of the National Research Council, formed in 1916, Dr. Mackenzie said that in 1939 it employed three hundred people, and there was a large reserve of well-trained research scientists. After the Second World War the Council undertook military and atomic energy research and now has six thousand employees. In agricultural research Canada spends 25–30 million dollars a year, or more per capita than any country in the world; Canada is now, and will remain, an industrial nation of the first rank. In reply to a question, Dr. Mackenzie said that since 1939 the National Research Council has lost only one senior man, and he knows of none who has left to go to the United States since 1946. In general, Canada has a surplus of research scientists; but more people are going from Britain to Canada than are going from Canada to the United States. Attention may also be directed to the article on the conference on "Canada's To-morrow" on p. 212 of this issue.

Commonwealth Conference on Human Problems in Industry

At a recent meeting, at which H.R.H. The Duke of Edinburgh, patron of the Industrial Welfare Society, presided, it was decided that a Commonwealth and Empire Conference should be held in Britain (probably at Oxford) during July 1956. The purpose of the Conference will be to bring together representatives from the Commonwealth and Empire who would pool their knowledge and experience of the human problems of industry in their own countries. It is intended that the age of the delegates should normally be between twenty-five and forty. The Conference will deal with the human factors in industrialization as a whole: on one hand the personal factors of the health, satisfaction, effectiveness and well-being of those working in industry; on the other, the social problems arising from the effects of industrialization on the lives of individuals, their families and communities. There is no suggestion that there should be consideration and discussion of the formal relationships between employers and trade unions, covering wages, conciliation and arbitration machinery, etc. Committees are to be set up to explore various aspects of the Conference, and a small steering committee, under the chairmanship of Sir Harold Hartley, was appointed to co-ordinate the work of the other committees. Further particulars can be obtained from the Industrial Welfare Society, 48 Bryanston Square, London, W.1.

Division of Man-made Fibres, University of Leeds

From October 1955 the Department of Textile Industries of the University of Leeds will consist of two Divisions—the present Wool Division and a new Man-made Fibres Division. Good progress is being made with the new building for the Man-made Fibres Division, which is situated in University Road, opposite the present Department. The building will cost £267,000, towards which a donation of £60,000 has been made by Courtaulds, Ltd., and £40,000 by an anonymous donor. It consists of four floors, the first floor being the most important as this will contain the pilot plant for the production of all present-day types of man-made fibres, machines for processing various fibres, looms and knitting machinery. The ground floor will contain the dyeing, printing and finishing sections and also two humidity rooms. The second floor will consist mainly of two large teaching laboratories, and on the third floor will be two lecture rooms, capable of housing 84 and 150 people, respectively, as well as a well-lighted design studio. On each of the four floors there will also be a number of research laboratories. It is estimated that the equipment for the Division will cost about £100,000, part of which is being contributed by private industry. The donations include £5,000 from the Tootal Broadhurst Lee Company,

Ltd., of Manchester, and £25,000 from the Man-made Fibres Producers' Committee, acting on behalf of the following producers: British Celanese, Ltd.; British Enka, Ltd.; British Nylon Spinners, Ltd.; Courtaulds, Ltd.; Harbens, Ltd.; Kirklees, Ltd.; Lansil, Ltd.; Lustrafil, Ltd.; Nelsons Silk, Ltd.; and North British Rayon, Ltd.

Very-high-frequency Broadcasting in Great Britain

THE first stage of the scheme by the B.B.C. to introduce sound broadcasting on very high frequencies, as envisaged in the second report of the Television Advisory Committee (see *Nature*, February 13, p. 297), has now received government approval, and work is proceeding in setting up the nine stations that will each send out the home, light and third programmes on frequencies in the range 88–95 Mc./s., using frequency-modulation. The stations will be in Wrotham (Kent), Pontop Pike (near Newcastle), Divis (Northern Ireland), Meldrum (near Aberdeen), Norwich, South Devon, Sutton Coldfield (near Birmingham), West Wales and Holme Moss (near Huddersfield), and will radiate 60 kW., except Wrotham, Norwich, Sutton Coldfield and Holme Moss, which will radiate 120 kW. The network is intended primarily to reinforce, and not supplant, the long-wave and medium-wave services already in existence and should make it possible to receive the three programmes free from interference in many areas where reception on medium wave-lengths is spoiled by interference and fading, especially after dark during the winter months. At Wrotham there are already two transmitters, which have been carrying an experimental service since 1950; a third transmitter will be installed, and the station will be brought into regular service in May next year. The other eight stations will be completed during the following eighteen months; they will be at the same sites as television stations, and the same masts will be used as for the television transmissions. The site for West Wales has not yet been settled. The radio industry in Britain is ready to produce receivers designed for very-high-frequency reception and adaptors for use with existing receivers, and these will become available in the various areas in time for the opening of the respective stations.

Scenes of Red Indian Life in the 1830's

DURING the 1830's, George Catlin, a self-trained artist, painted more than five hundred pictures of Red Indians and Western scenes in the United States, and the majority of these are now lodged in the Smithsonian Institution, Washington, D.C. Through the Information Section of the American Embassy in London, a selection of twenty-seven paintings are being shown in the Whitechapel Art Gallery, London, and this exhibition will continue until August 8 (admission free; daily 11 a.m.–6 p.m.; Sundays, 2–4 p.m.; closed Mondays). In conjunction with the Catlin paintings, there is also the Combined Societies Exhibition of International Photography, 1954. Catlin took great trouble over his work and was well aware of the importance of accuracy, so that his paintings are authoritative records of the life and appearance of Red Indians a hundred and twenty years ago. The paintings at the Whitechapel Art Gallery cover mainly his journeys in the Santa Fe–Fort Gibson area (lying within New Mexico, Texas and Oklahoma) during 1834 and in the Fort Clark–Fort Pierre area (lying within North and South Dakota) during 1832, and depict respectively Mandans and Sioux. Though perhaps the art is not of a first-rate order, the paintings (which are in oil on canvas) are nevertheless very pleasing by the great dignity of the sitters conveyed in the posed portraits, and by the free, lively, almost Impressionist, style of some of the landscapes and broad scenes of village life; the colours are agreeably subdued. It is interesting to note that, after touring the United States in 1838–39, the majority of Catlin's paintings were housed during the 1840's in London at his gallery in 6 Waterloo Place, and his account of his exploits were published in England in a two-volume work entitled "Letters and Notes on the Manners, Customs, and Conditions of the North American Indians" by Geo. Catlin, "Written during Eight Years' Travel amongst the Wildest Tribes of Indians in North America, in 1832, 33, 34, 35, 36, 37, 38, and 39"; a copy of the third edition of this work, dated 1842 and published by Tilt and Bogue, of Fleet Street, London, is on show at Whitechapel and contains four hundred line engravings which Catlin prepared from his original paintings.

Thirty-five Catlin paintings have been acquired by the Chicago Natural History Museum, and these are reproduced in a little book by George I. Quimby, curator at the Museum, entitled "Indians of the Western Frontier: Paintings of George Catlin". Red Indians in various kinds of costumes are depicted, and there is also an interior, a hunting scene and two or three drawings of bison.

Scientia Electrica: New Swiss Journal of Applied Electricity

IN the past thirty years the scientific principles used in electrical engineering have become more complicated and recondite, and the volume of scientific papers has correspondingly grown. In Great Britain the Institution of Electrical Engineers has found a place for all types of papers concerned with electrical science, except for a small number published by the Royal Society, Physical Society, Institute of Physics and elsewhere. The position is not so satisfactory abroad, and a new journal, *Scientia Electrica: Moderne Probleme der theoretischen und angewandten Elektrotechnik* (Band 1, Heft 1, October 1953, pp. 40, 4 Fr.; Heft 2, January 1954, pp. 42, 4 Fr.; Heft 3, June 1954, pp. 46, 4.80 Fr. Zurich: S. Hirzel Verlag), edited by Prof. Max Strutt, has been started in Switzerland to cover current advances and problems in the scientific aspects of the theory and practice of electric technology; the contents of the first three numbers are contributed from colloquia given at the Technical High School, Zurich, by leading experts. It is intended to publish submitted articles of suitable merit within the given terms of reference. The articles so far published contain reviews of recent progress together with some original work of the authors. The subjects chosen are both interesting and important, such as transistor amplifiers, fine transfer in contacts, corona loss in high-voltage transmission, absolute voltage measurement, new insulating materials, and backfires in mercury arc rectifiers. Presumably, submitted articles will often be of narrower scope and confined to original work. If so, those concerned in electrical science will certainly have to take note of this new journal. Even should the articles remain somewhat of a review type, the important work on applied electricity in Switzerland and the standing of the journal's sponsors are such as to ensure the standard and usefulness of its contents.

Staffing of Grammar Schools

In July 1953, a sub-committee of the North-West Division of the Incorporated Association of Headmasters instituted an inquiry into the qualifications, length of service, age distribution and extra remuneration of the teaching staff in the boys' and mixed grammar schools in the area covered by the counties of Lancashire and Cheshire. The inquiry was also concerned with the size of schools, the strength of sixth forms, and at a later stage the academic qualifications and ages of headmasters. The main intention of the survey was to throw light upon the known shortage of teachers in some subjects taught in grammar schools, to view the deployment of specialist and other teachers, and to study the way in which special responsibility allowances which supplement the basic Burnham Salary scales had been awarded. The survey was conducted by W. E. Egner of the Grammar School, Ormskirk, and A. Young of the University of Liverpool. Their report (pp. 20; from the University of Liverpool; 1954; 2*s*.) presents summarized details of the more interesting information elicited by the inquiry, special attention being paid to teachers of science and mathematics; the information analysed has been obtained from sixty-six grammar schools.

National Institute for Research in Dairying, Shinfield: Report for 1953

In the annual report of the National Institute for Research in Dairying of the University of Reading for 1953 (pp. 138+1 plate; from the Institute, Shinfield; 1954; 3*s*.) the policy of 1952 has again been adopted of presenting in outline a selection of the advances that have been accomplished during the year under review, particularly some of those with a more practical and obvious interest. This is a very useful measure and serves also to pin-point some of the highlights of research of this team of distinguished scientists. There is still the customary series of extended summaries of researches in progress (or recently completed), and these, together with notes on staff and their publications, constitute a closely packed volume of 138 pages. The director of the Institute, Prof. H. D. Kay, points out that in the selection of advances which have been summarized in brief the choice is of necessity arbitrary and omits reference to much of the work in progress. The product of a collaboration with Sir Charles Dodds and members of his staff at the Courtauld Institute of Biochemistry, London, has been the finding of two *iso*flavones with œstrogenic properties (but far less active, weight for weight, than the naturally occurring œstrogens synthesized by the animal), biochanin A and formononetin, which have been isolated in a pure form from red clover. They have approximately the same œstrogenic activity as the closely related genistein, which is believed to be responsible for much of the œstrogenic activity of subterranean clover. Many of the other advances are of very great interest and importance to the industry, and Prof. Kay and his colleagues are to be congratulated on this outstanding record of achievement.

Enzymic Decarboxylation of γ-Methyleneglutamic Acid by Plant Extracts

The enzymic decarboxylation of γ-methyleneglutamic acid by various plant extracts has been demonstrated by L. Fowden (*J. Exp. Bot.*, **5**, 28; 1954). He has shown that γ-methyleneglutamic acid, an acidic amino-acid isolated from groundnut plants, was decarboxylated by enzymes present in extracts of *Capsicum* fruits, barley roots and tulip leaves, and also by intact cells of *Clostridium welchii* S.R. 12. The amino-acid was attacked in a similar manner to, but in all cases at a slower rate than, *l*-glutamic acid. The nature of the enzyme responsible for the decarboxylation of γ-methyleneglutamic acid was further investigated, using preparations from barley roots (which do not contain the amino-acid) and from tulip leaves (in which the amino-acid is normally present, together with larger amounts of its amide form, γ-methyleneglutamine). The effects of *p*H, inhibitors and partial heat denaturation upon the enzyme systems present in the barley and tulip extracts indicated that a single enzyme was responsible for the decarboxylation of both *l*-glutamic acid and γ-methyleneglutamic acid. Although the *Cl. welchii* rapidly deamidated and then decarboxylated *l*-glutamine, γ-methyleneglutamine was not attacked by the organism.

Bowen Prizes for Papers on Scientific Instrumentation

The Institute of Physics has awarded Bowen Prizes of fifteen guineas to the following for papers published in the *Journal of Scientific Instruments* during 1953: A. G. Milnes and T. V. Vernon (jointly), Royal Aircraft Establishment, Farnborough (saturable-core reference source for use with magnetic amplifiers); G. D. Dew, National Physical Laboratory, Teddington (preparation of plane diffraction grating replicas for helical rulings); and G. D. Archard, Research Laboratory, Associated Electrical Industries, Ltd., Aldermaston (magnetic electron lens aberrations due to mechanical defects). The Prizes are awarded to persons less than thirty-five years of age for papers of originality, scientific value and practical utility to instrument makers and users. The money is provided by the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., from the Bowen Trust Fund established by the late Mr. William Bowen.

University Teachers: Conference in Vienna

The eighth Conference of University Teachers, organized by the International Association of University Professors and Lecturers, will be held in Vienna during September 9–14 at the University of Vienna and at the Vienna Hochschule für Welthandel, under the chairmanship of Prof. Francesco Vito, of Italy. The Conference will be open to all members of the Association and of its affiliated national associations of university teachers, to university administrative staff, and to others directly interested in matters of university education; university institutions in which there are, as yet, no sections of the Association are invited to send representatives of their teaching staff. The topics to be considered include the following: relations between scientific research in the universities and in industry; selection of students for university entrance (in particular, the systems and the extent of their assistance from public funds, bursaries, scholarships, etc.); conditions of employment of university teachers abroad, and the contractual obligations involved; main obstacles to the international exchange of university teachers; and methods of international co-operation in the university and scientific spheres. A registration fee of £1 will be charged. Further details can be obtained

from the Secretary, IAUPL, 19 Dunraven Street, London, W.1.

Utilization of Fish and Agricultural Food Products

A CONFERENCE on new developments in the utilization as food of fish and agricultural products will be held in Aberdeen during September 30–October 2, under the auspices of the Society of Chemical Industry (Aberdeen Section and the Food and Agriculture Groups) and the Institute of Biology (Scottish Branch). The conference will be opened by Dr. F. N. Woodward, director of the Institute of Seaweed Research, and Dr. Norman Wright, scientific adviser to the Minister of Food, will give the closing address. Topics to be discussed are: the feeding values of oats, straw and oat-milling products; the vacuum dehydration of foodstuffs; freezing at sea; quality of sea-frozen cod; recent developments in fish by-products; supplements in the rations of livestock; distillery by-products, and their recovery and use as animal feeds; seaweeds and their constituents as foodstuffs; large-scale culture of microscopic algæ as food. There will be visits to the Ministry of Food Experimental Factory, the Torry Research Station and the Rowett Research Institute. A detailed programme and registration form will be available early in August from the Honorary Secretary (F. T. Walker), Institute of Biology, Scottish Branch, 25 Inverleith Gardens, Edinburgh 4.

University of London

THE title of professor emeritus in the University of London has been conferred upon the following on retiring from their respective chairs: Prof. H. V. A. Briscoe, inorganic chemistry at the Imperial College of Science and Technology; Prof. H. Munro Fox, zoology at Bedford College; Prof. Morris Ginsberg, sociology at the London School of Economics and Political Science; and Prof. Hyman Levy, mathematics at the Imperial College of Science and Technology. The following have been appointed to University readerships, tenable at the institutions indicated: Mr. D. G. MacRae, sociology at the London School of Economics and Political Science; Dr. R. G. White, bacteriology at the London Hospital Medical College; and Dr. J. H. Wilkinson, chemical pathology at Westminster Medical School.

The Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: L. W. Harwood and N. Lamont (agricultural officers, Fiji), senior agricultural officers, Fiji; R. J. M. Swynnerton (assistant director of agriculture (field services), Kenya), deputy director of agriculture, Kenya; R. P. St. John Watkin (chemist, Tanganyika), assistant government chemist, Nigeria; G. S. Brown (senior assistant conservator of forests, North Borneo), senior assistant conservator of forests, Federation of Malaya; W. B. Tevendale (geologist, Geological Survey Department, Gold Coast), senior geologist, Geological Survey Department, Gold Coast; D. A. R. Campbell, V. T. Domville and B. F. Topper (agricultural officers, Jamaica), senior agricultural officers, Jamaica; A. S. Martin (medical officer, Jamaica), assistant bacteriologist, Jamaica; R. Foster, scientific officer, Tanganyika; R. N. Gourlay, veterinary officer, Uganda; J. M. Ross, veterinary officer, Northern Rhodesia; R. N. Chrystal, forest entomologist, Cyprus; C. D. Cooke, veterinary officer, Nigeria; J. V. Thirgood, sylviculturist, Forestry Department, Cyprus.

The Night Sky in August

FULL moon occurs on August 14d. 11h. 03m., U.T., and new moon on August 28d. 10h. 21m. The following conjunctions with the moon take place: Aug. 2d. 18h., Venus 6° N.; Aug. 6d. 03h., Saturn 8° N.; Aug. 10d. 08h., Mars 3° S.; Aug. 25d. 01h., Jupiter 1° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Pollux on Aug. 3d. 23h., Mercury 7° S., and also in conjunction with Uranus on Aug. 4d. 12h., being 0·6° S. of Uranus. On Aug. 31d. 01h., Venus is in conjunction with Spica and is 0·1° N. of the star. During the first part of the month Mercury is visible as a morning star, rising at 2h. 50m. and 4h. on August 1 and 15, respectively, and is in superior conjunction on August 21. Venus, an evening star, sets at 21h. 10m., 20h. 35m. and 19h. 50m. at the beginning, middle and end of the month, respectively; the visible portion of the illuminated disk varies from 0·655 to 0·523, and the stellar magnitude from −3·6 to −3·9. Mars sets very soon after midnight on August 1, and at 23h. 25m. and 22h. 45m. on August 15 and 31, respectively; but as its declination is about 28° S., it is not very favourably placed for observation in the British Isles. Jupiter is a morning star, rising at 2h. 25m., 1h. 45m. and 1h. on August 1, 15 and 31, respectively. It is easily identified (stellar magnitude −1·5), and its motion from west to east of δ Geminorum during the month is obvious. Saturn, an evening star, sets at 22h. 35m., 21h. 40m. and 20h. 40m. at the beginning, middle and end of the month, respectively, stellar magnitude 0·9. Its slow easterly motion from κ Virginis is easily detected. The Perseid meteors attain a maximum about August 10–12, but bright moonlight will interfere with their observation. No occultations of stars brighter than magnitude 6 occur during August.

Announcements

THE University of Leeds has conferred the title of reader in physics on Dr. F. E. Hoare, senior lecturer in the Department of Physics; Mr. E. W. Bennett has been appointed lecturer in the Department of Civil Engineering of the University.

THE University of Cape Town is offering a scholarship of £200 a year tenable for three (or possibly four) years to a student from Great Britain proposing to take a degree course at the University, beginning in March 1955. Applications should be forwarded not later than August 15 to the Secretary of the Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

THE Research Fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About £700 a year is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants should be submitted to the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, on the appropriate form not later than November 5.

THE third conference of the British Occupational Hygiene Society will be held at the London School of Hygiene and Tropical Medicine on November 1; it will be devoted to a discussion of radiation hazards in industry. Application forms for the conference can be obtained from the Hon. Secretary of the Society, Mr. P. C. G. Isaac, Public Health Engineering Laboratory, King's College, Newcastle upon Tyne.

TECHNICAL COLLEGES AND INDUSTRY IN BRITAIN

THE papers presented at the Conference on Technical Colleges and Industry arranged by the Education Committee of the Federation of British Industries at Ashorne Hill on May 5–7 covered a wide field. They attempted to formulate industry's ideas as to what it expects of the technical colleges in Britain, and, on the part of the technical colleges, to present the perspective in which the colleges work and their relations to the universities and the schools as well as to industry itself. Such discussions flowed naturally on to the broadening of the technical college and its place and function in training for management.

So far as the Conference leaves any dominant impression, it is one of the complexity of the whole problem of technical education in Britain, and the futility of any attempt to improve its standard or expand the provision for technical education without taking full account of the educational system of the country as a whole from university-level downwards, and in co-operation with industry. The inadequacy of such piecemeal tactics as the Ministry of Education has hitherto followed was clearly displayed, by implication rather than by explicit condemnation. There was no attempt to formulate a definite policy at the Conference; but essential features of any effective policy were indicated, though at the same time the need for flexibility and variety was equally stressed. It was certainly made clear that many sections of industry are already fully prepared to co-operate and that there should be a generous and prompt response to a clear and bold lead.

Sir Arthur Smout (Murex, Ltd., and Murex Welding Processes, Ltd.), in some outspoken comments on the present position, urged afresh the establishment of a Technical College Grants Committee on a par with the University Grants Committee, which would enable the administration and finance of at least the major technical colleges to be taken out of local and party politics. He insisted, too, that we cannot expect to have an educational system worthy of a great nation on the cheap, and while it was evident that industry as represented at the Conference is likely to support generously a policy of expansion for technical education, such support presupposes a policy and a recognition by the Government that technical education is a sound investment. Moreover, while it seemed to be generally admitted that only a relatively few technical colleges could be expanded into major institutions under such a policy, the importance of the contribution to be made to technical education by the rest was equally recognized. Dr. P. F. R. Venables (principal, Royal Technical College, Salford) suggested that the term 'higher technological education' should be restricted to post-graduate education; and this suggestion might well help not only to remove confusion but also to eliminate the difficulty, real or imaginary, which is sometimes caused by status. Dr. Willis Jackson, indeed, expressed the opinion that the weakness of Great Britain relative to the United States is at the level of technique and not at the professional level, and that post-war discussions here have concentrated too much on the professional grade rather than on the technician.

Much that was said at the Conference served to clarify these interrelationships. Sir Arthur Smout, for example, pointed out that we must get away from the idea that all higher education must be of the university type, and he visualized the technical colleges as the appropriate means for training for industry young men who are ill-suited and ill-equipped for university life. Further, he believes that a main purpose of the 'sandwich system' is to encourage a good type of recruit to join smaller firms direct from a grammar or secondary school and obtain the appropriate technical training in a technical college while based on the works. Apart from thus integrating practical training in the factory with technological studies in the college, Sir Arthur sees great advantages in bringing the smaller firms into relationship with technical colleges in this way.

The importance of maintaining a variety of channels for technological training was emphasized by other speakers. Dr. Venables pointed out that the fulcrum of the definition of technology is in the scientific study, while with a craft it is in the exercise of a skill or technique. Fundamentally, a technology requires the student to undergo an exacting scientific discipline which confers mastery of the theoretical concepts required for widely differing ends. In his view the difference between technological education in the universities and in the technical colleges is simply one of the timing or phasing of the two main elements—the science and the art of the technology. In the universities, the phasing is preponderantly scientific, with the art phase introduced mainly as a pre-undergraduate year, as brief intermittent phases of vocational experience in industry, and a thorough postgraduate phase; but for most technical college students the phases are more interpenetrating or even concurrent or alternate as in 'sandwich courses'. While he believes there is an ample reserve of ability in Britain for training in technical colleges, it is on condition that such expansion of the technical colleges does not contemplate the raising of more than the minority of such colleges to provide largely technological, as distinct from technician or craft, education. We should preserve flexibility and also encourage transfer between courses and occupations, so that the best ability when found can be moved forward and upward.

Dr. Venables suggested that the main elements in our policy should be the development of 'sandwich courses' on a recognized national basis, a national standard of intake and a national length of courses. This would remove much of the present confusion, and though he believes it is also desirable that more research should be carried out in the technical colleges, that depends on the recruitment of the appropriate staff and the establishment of conditions of service which will attract competent men. Dr. Willis Jackson (Metropolitan-Vickers Electrical Co., Ltd.) supported Dr. Venables in his general view as to the relative functions of the universities and the technical colleges; the latter, he suggested, should provide courses which are more technical and more related to industrial practice. Some university courses are already technical enough, and he would like to see the universities rather ensure a sounder foundation

in pure science. Moreover, in view of the increasing interrelation of different branches of technology and their increasing mutual dependence on pure science, he believes they should be drawn together at a comparable level and in intimate association with pure science departments of high standing.

Dr. Jackson did not minimize the difficulty of any such attempt; but he also urged that the technical colleges rather than the universities should encourage the development of short-term specialist courses, whether full-time or evening, and the universities should concern themselves only with the scientific and analytical foundations of prospective technological development—with what industrial practice should be five or more years ahead rather than with what it is to-day. The technical colleges, moreover, can only make their full contribution in the teaching of current industrial practice if industry is willing to co-operate to the extent of making available the services of the appropriate senior members of its staff.

In opening the discussion on the broadening of technical education, Sir Reginald Vernon Smith (Bristol Aeroplane Co., Ltd.) pointed out that the responsibility once again rests with the schools and industry as well as with the technical colleges. So far as industry is concerned, the standard of selection adopted by industry for its recruits is an important factor, as is the pattern of training afterwards given. Technical education, moreover, is a continuing process and much can be done by the intelligent and liberal use of postgraduate courses, residential courses, interchange schemes, overseas travel fellowships and the like. On the part of the technical colleges, he suggested, like Dr. Venables, that emphasis should be placed more on the fundamentals or intellectual discipline of a technology than on the applications, and that technical subjects should be presented against a stimulating background of historical development and in relation to allied subjects. The latter suggestion found confirmation in Prof. Rex Knight's observations on the probable reaction of technical college students to the widening of their programme of studies. Prof. Knight (professor of psychology, University of Aberdeen) believes that any new subjects must be linked to subjects of which the vocational significance is clear; they must be seen by the student to be an integral part of the preparation for the job he is to do in industry. They must also, he thought, form part of the target the student has to hit, though not necessarily as subjects of examination. Prof. Knight also remarked that much of the widening of curriculum would have to be done in industry, and while he believes that in the technical colleges, even more than in the universities, there is great need for grading students according to their ability and educational achievements, to facilitate both the prosecution of their individual studies and the removal of specific defects in their educational equipment, he stressed finally that all such further education is dependent on effective co-operation between all concerned. He also endorsed Dr. Venables's remark as to the importance of social facilities, and the suggestion that the Federation of British Industries might press for greater proportionate facilities for technical college students.

Mr. H. A. Warren (principal, South-East London Technical College), who followed Sir Reginald Verdon Smith, from the point of view of the technical colleges went rather deeper into the implications of the broadening of technical education. It should be remembered, he pointed out, that this age is extremely preoccupied with technics, and we have above all to present technics or technology as a means to an end in terms of human values, not as an end in itself. If we fail to put power into the hands of the coming generation with a sense of purpose and of responsibility, we are in danger of being overwhelmed by an environment of our own making. Technical education, moreover, is wholly secular, and more regard should be paid to those fundamentals of the human spirit which limit and constrain technical education. With much of what Prof. Knight said he agreed; but he emphasized that the decisive factor is the outlook and capacity of the teacher, and here, he said, the Federation of British Industries can be of great assistance. The Federation can also make it widely known that industry desires and values this broadening of technical education.

Dealing specifically with management studies in the technical colleges, Mr. Bertram White (formerly technical director of the Federation of British Industries) said that the technical colleges have here a valuable but limited contribution to make. He too stressed the importance of the quality of the teaching and suggested that the Urwick Committee was over-optimistic in its estimate of the potential supply of men and women with appropriate experience willing to devote part of their time to the teaching of management. He believes that lectures on management are often delivered by teachers with no practical industrial experience; indeed, generally the business community lacks the faculty of coherent and articulated expression of its ideas. While much closer association with the professional associations is required, any further development of management studies should proceed by way of agreement. Much closer association between the technical colleges and local industry is required, particularly in teaching the various techniques through which management achieves its purposes. Besides this, technical colleges in their management studies should endeavour to teach background subjects: those aspects which are usually termed 'general management' subjects are best learned on the job under good supervision. Industry must train its own managers; the role of the technical colleges is supplementary. He advocated the abandonment of courses that are ineffective and cannot be improved and also, for the next decade, disregard of certificates and diplomas in management studies. The Federation of British Industries and the British Institute of Management should confer with the associations of technical institutes to ascertain those areas of the country in which more co-operation between industry and the technical colleges and greater awareness of the value of management training are required.

Mr. J. Wilson (principal, Birmingham College of Technology), who followed, agreed that most of the difficulties in education for management arise from over-enthusiasm and pressure for development started up by the Urwick Report. There has been some lack of consultation with industry; but the staffing position is the critical factor and limits the rate of progress. He also agreed that it is desirable to concentrate highly qualified staff in a few centres providing facilities for all levels of interest in industrial administration. The urgent need in the training of men for management is to bring into partnership all those bodies already concerned with it separately, from universities to trade unions, from technical colleges to professional associations, and from public to private enterprises.

CANADA'S TO-MORROW

THE Canadian Westinghouse Co., Ltd., believes that "business and industry can flourish only as the whole nation advances in the direction of the good life", and a few months ago expressed its appreciation of fifty years spent in Canada in a rather unusual way—by the sponsoring of a conference at Quebec for the study of the country's future. The papers read at the conference provided an excellent picture of Canada's past and present, and also gave some glimpse of the future. "A sober, calm, highly critical assessment" was the description of one of the guests, who remarked on the lack of that complacency which might so easily have resulted from the sudden upsurge in the country's fortunes. Canadians of the calibre of the eight conference speakers clearly have a very realistic grasp both of Canada's internal situation and of the part that her people must play in the troubled world of to-day.

Canada's resources are both human and natural. B. K. Sandwell discussed the people, whose numbers, he is convinced, could be greatly increased without adversely affecting the present high standard of living, so great are the country's resources and so vast the potential market for primary and secondary products, both within Canada and in the United States and elsewhere. The natural resources were discussed in a comprehensive stocktaking by Maxwell W. Mackenzie. He stressed in particular the suitability of the timber of the Canadian Shield for newsprint, the value of the mineral resources of the Shield and other areas, and the significance of the fact that hydro-electricity can easily be transmitted to the points where energy is required. He believes that the time has come for electricity, gas and oil to be distributed through a national network, since their part in Canada's future must be at least as great as has been the contribution of rail, road and water transport in the past. He also emphasized the importance of conservation practices and research programmes, especially for timber and cereals, which together accounted for 45 per cent of the value of Canada's exports in 1951. Food production, apart from wheat, should, he suggested, be based on probable domestic demand. The United States and other countries should still be permitted to purchase primary products such as timber, though at the same time Canada must press for the reduction of trade barriers, especially those which prevent the export of processed products such as plywood and composition boards. She must also be courageous in her attitude towards, and exploitation of, her extensive resources. He sees no justification for the hoarding of the nation's very considerable wealth of copper, lead, zinc, nickel, cobalt, tungsten, iron ore, titanium and other lesser known but important alloy metals, or for placing restrictions upon the export of primary products. The mining of the iron ore of Labrador and of lead and zinc at Pine Point on Great Slave Lake, for example, would undoubtedly result in the opening-up of vast new stretches of country.

These great resources, while providing Canadians with considerable material comfort and higher standards of living, also help to give rise to what R. K. Stratford, scientific adviser of Imperial Oil, Ltd., called "the greatest social challenge in history". Several of the papers dealt with the impact of economic development upon the social and political life of the community, through education, industry and government. It was recognized that "we refuse to give to our hearts and minds the thought and care that we lavish on our physical needs", and that far more attention is commonly directed to the problems of industry and resources than to the study of urban and rural social problems. One speaker pleaded for the expansion of university departments, whence might come "long, systematic studies of the human being under different environmental conditions". Another deplored the gap between the two main cultures, the French and the English, and advocated the erection of bridges across the cultural gulf: this, she believed, might be achieved by an increasing sense of the need, "not for a superficial and chatty bilingualism, but for a genuine mastery of the two languages". Realistic recognition was also given to the third great cultural force, that of Canada's neighbour, the United States. Faced with these various influences and traditions, there should be encouraged in Canadian schools "individual self-reliance in opinion, critical dissidence, intelligent nonconformity, the ability at least occasionally to stand aside and stand up for one's own individual beliefs".

The role of government, in economic and social affairs, has changed considerably during recent years. Government encouragement of economic activity, as in the building of communications and the fostering of settlement, has given way to private enterprise, and public authorities are now increasingly concerned with social security and short-term economic stability. Prof. Maurice Lamontagne, of Laval University, claimed that the Canada of the future needs neither capitalism nor socialism but a complementary relationship between private initiative and government action, with the Federal Government playing a dominant part in the collective effort to maintain economic equilibrium.

Prof. D. G. Creighton, professor of history in the University of Toronto, turned the thoughts of the conference to Canada's place in the world. The country has already established her independence within North America and a prominent place in the Commonwealth, and is rapidly securing for herself an acknowledged position in international affairs. She has, in his view, to accept a world in which Communism dominates the larger part of Asia, and must be prepared to abandon what he called "our complacent, parochial North Americanism". It is essential that Canada should give to the United Nations its steady support.

At the close of the conference Prof. D. W. Brogan, as "an outsider looking in", surveyed the wide range of papers and subjects discussed. He said he was impressed by the wealth of Canada's resources, but he saw "the basic source of Canadian prosperity in the character of the Canadians and of their civilization". Canada has shown the world that the highest potentialities of modern technology are attainable without violence, disorder, or cultural savagery. As population increases—as it should—by natural increase and by immigration, the specifically Canadian aspects of North American culture must be fostered and the double culture of Canada steadily fused. Each group must express its own vision of Canadian life, at the same time sharing that vision with its neighbour. Canada, Prof. Brogan reminded his listeners, "is the heir of the two great formative traditions of western Europe: it is her pride and opportunity to develop both".

Canada's to-morrow is bright and promising because Canadians are proud of her past and conscious of the opportunities of the present. Through the public spirit of a great concern—typical of many of the corporations of North America—and because of its

confidence in the nation's future, more than three hundred representatives of Canada's commercial, industrial and cultural life were able to share in the thoughts and concerns of a few of their fellow-countrymen through this conference.

The papers form an invaluable commentary on Canadian thinking to-day, and on Canada's prospects to-morrow. Fortunately, the Canadian Westinghouse Co. has now published the papers in book form*, thus making available for a much wider audience the deliberations of this very balanced and comprehensive conference. ROBERT W. STEEL

* Published by the Macmillan Co. of Canada, Ltd., 70 Bond Street' Toronto. 3.50 dollars.

THE SPORTS TURF RESEARCH INSTITUTE

SILVER JUBILEE

TO mark the silver jubilee of the Sports Turf Research Institute, a conference and open day were held at its headquarters, St. Ives Research Station, Bingley, Yorkshire, on July 1. A most satisfactory attendance, including representatives from sports clubs, sports associations, education authorities and municipalities throughout the British Isles, was presented with a very full day's programme in which major items were experiment plot demonstrations, educational exhibits, displays of modern machinery and the presentation of various papers on turf topics at intervals during the day.

The director of the Institute, Mr. R. B. Dawson, spoke about the developments of scientific turf management during the past twenty-five years, stressing particularly the big improvements in design and range of equipment that have taken place. He referred also to the growth of the experimental and other work of the Research Station. Mr. J. R. Escritt (soil chemist) discussed the relative importance of physical and chemical properties of soils for turf production, and Mr. J. Drew Smith (plant pathologist) dealt with turf diseases and his own work on fungicides. The fourth paper, given by Mr. G. Wright, a member of the Board of Management, described turf research work in progress at several research centres in the United States, emphasizing the big problems created in some parts by climatic factors adverse to good turf production.

The Institute (formerly known as the Board of Greenkeeping Research) has the stated aim of raising the general standard of sports turf. It is supported by subscriptions from numerous interested bodies, including sports clubs, golf clubs, industrial welfare clubs, sports associations, public authorities and education committees. Management of the Institute is in the hands of a Board of Management which includes representatives of the main sports controlling bodies, namely, the English Golf Union, Scottish Golf Union, Golfing Union of Ireland, Welsh Golfing Union, Football Association, Football League, Ltd., Lawn Tennis Association, Rugby Football Union, Rugby Football League and the English Bowling Association. The Board has available both scientific and practical advisory committees for consultation. In pursuance of its object, the Institute has a comprehensive research programme for investigating problems of general turf management, problems of individual management of turf for particular purposes and, of course, the control of weeds, pests and diseases. Extensive field trials running to many hundreds of plots are backed by useful laboratory facilities.

Field work at present in progress at the Research Station (and demonstrated on the open day) includes trials on height of cut, top-dressing materials, long-term fertilizer treatment, weed control, disease control, grass growth stunting and seeds mixtures. Although the main experimental ground bears a considerable number of trials, many experiments can only be carried out satisfactorily at outside centres; for example, at present a new series of simple trials on seeds mixtures for renovating football grounds is in progress. Turf diseases and their control are receiving particular attention at the moment, with attempts to produce cheaper and more efficient materials for controlling known turf diseases. It is interesting to note that this concentration on disease problems has revealed that one or two new diseases previously unrecognized occur quite frequently, and work is proceeding on methods of control.

Knowledge gained from the various trials is passed on through the advisory work of the Institute, through instructional courses for groundsmen, greenkeepers and other interested persons and also through lectures given by members of the staff at various centres throughout Great Britain. In addition, an annual *Journal* is produced and also brief quarterly *Bulletins*, both these publications being circulated to all affiliated members. The advisory services are being increasingly called upon, and more and more is being demanded of the staff concerned in this work.

The Institute was founded in 1929 by the golf clubs through the four national Unions; but the great expansion of activities, particularly since the Second World War, in various other directions, led to a reorganization and the formation of the Sports Turf Research Institute. The status of the organization as an independent non-profit-making scientific body was recognized by the granting of a licence from the Board of Trade in August 1951, thus permitting the Institute to be registered and to operate without the use of the word 'Limited' in its title. The former Board of Greenkeeping Research ceased to exist on September 3, 1951. It has become increasingly obvious that the Institute has an important part to play in the future as in the past. More and more its advice is called upon in the construction of new playing fields for all kinds of bodies. In particular, the educational programme of producing more new school playing fields demands a great deal of attention from the Research Station in order to enable the education authorities to produce fields of sufficient quality without unnecessary expenditure of public funds.

DEVELOPMENT AND UTILIZATION OF WATER RESOURCES

THE eighteenth session of the United Nations Economic and Social Council, which opened in Geneva on June 29, discussed among other items a report on the Development and Utilization of Water Resources*. This report was prepared as a result of earlier resolutions calling for information on the work being done by the specialized agencies and

* United Nations: Economic and Social Council. Report on the Development and Utilization of Water Resources. Pp. 20. (London: United Nations—London Information Centre, 1954.)

other international organizations engaged in the broad field of water control and utilization.

The complex nature of the inter-relationship between the various factors which have an influence upon, or are in turn affected by, the availability of water is first stressed—the needs of agriculture, inland navigation, industrial and domestic demands, electric power and the like are considered in relation to techniques of conservation to prevent excessive run-off, soil erosion and flood damage. The report then directs particular attention to three aspects: the first need in any activities on water control is the organization of a continuous collection of hydrological data which must be available for a considerable stretch of years to be of any value; in this connexion the suspension of the United Kingdom Inland Water Survey (referred to in *Nature* of November 7, 1953, p. 823) is again seen to be a retrograde step.

Secondly, attention is directed to the topic of watershed management, as this is regarded as an important but neglected aspect of water conservation. It is claimed that effective control in these initial stages reduces the need for river-training works and downstream flow-control measures. It is suggested that there is a regrettable lack of understanding of watershed management, not only on the part of the general public but also among those who are responsible for the political and economic decisions which are often made on water supply. The need exists to build up a body of information on this subject and also to arrange for its dissemination, perhaps through Unesco. The third aspect selected for special attention is the use of water for industrial purposes. This is considered to be the largest single factor making for the increased demand for water which is being experienced in most countries of the world to-day. Some dramatic illustrations of the growth of this demand are given: in 1950 the industrial use of water in the United States was higher than the agricultural use, and the Paley Commission estimates that by 1975 industries will use two-thirds of all sweet water and that availability of water will be the main determining factor for industrial location. To produce a ton of steel now requires 65,000 gallons of water, and to refine a barrel of crude oil requires 18½ barrels of water; a ton of sulphate paper needs 64,000 gallons, while almost astronomical figures are required for thermal generating stations and atomic power stations.

To meet these and related problems of water pollution, the report considers the possibility of a more effective integration and co-ordination at various levels of the interested agencies and organizations. A strong case is made for the creation at national level in each country of a 'water board' representing all the interested government departments and local government bodies concerned with any of the numerous aspects of water conservation and utilization. This is a recommendation that might well receive careful consideration in the United Kingdom, although we are not alone in this lack of one central body: few countries have so far succeeded in co-ordinating their local activities on water development. Until this has been done, however, there seems little hope of efficient and successful co-ordination and co-operation at the regional and international level. Meanwhile, it is recommended that the United Nations Organization should encourage the holding of technical conferences and meetings of existing hydrological agencies. The United Nations Organization should also serve as a clearing house on water matters and perform such other functions as it may appropriately undertake in implementation of the Economic and Social Council's resolution on water control (Resolution 417, XIV).

W. G. V. Balchin

NETWORK ANALYSER OF THE ELECTRICAL RESEARCH ASSOCIATION

THE alternating current network analyser has now become established as an essential tool for the design, operation and study of electrical power systems. The direct representation of the electrical characteristics of the network components by variable calibrated elements with suitable sources of alternating current, flexible means of interconnexion and sensitive measuring equipment readily applied to any point on the network makes possible examination of a complicated network for power flow, transmission efficiency, stability and fault conditions with an ease and accuracy quite beyond the range of human computation, while permitting an experimental approach as yet impracticable with a digital computer. The same equipment can in principle be used in the study of any systems capable of representation by linear differential equations and certain non-linear problems within a range dependent on the versatility of the components and measuring equipment.

The network analyser constructed by the Electrical Research Association, the first completed section of which was exhibited to the technical and scientific press on April 28, has been designed for application to the widest possible range of problems. To this end the equipment can operate at any frequency from 160 c./s. to 16 kc./s., so that frequency can be a variable or one of the unknowns in a problem. The maximum accuracy is at the 'base' frequency of 1,592 c./s. ($\omega = 10^4$). This versatility is accompanied by the possibility of extension to a size not less than that of any existing analyser. The equipment is believed to be unique in providing steady-state, transient and harmonic solutions on the same installation.

The impedance elements, mounted in racks, are connected by twin cables to terminals on a 'plug board' and thence by pairs of flexible cords to plugs which can be inserted into sockets in an interconnecting board to form the nodes of a network. The potential drop across a 20 milliohm shunt in series with one of the flexible cords associated with each element, and the potential difference between any two nodes of the network may be connected by a selection system to the terminals of the central measuring equipment which indicates simultaneously current, voltage, load and reactive load at the selected points. Two independent selection systems, which can be cross-connected, make this measuring equipment extremely versatile. Monitoring and fault-finding indications are provided.

Physically small components used in the network elements yield an inexpensive and compact design with short interconnecting leads and thus increased frequency-range. Small components require a low power-level, to avoid thermal effects in resistors and non-linearity in inductors. The level adopted is 2·5 mW., 500 mV. and 5 mA. for the base (that is, 100 per cent) values, with a range up to 400 per cent

in voltage and current. This means that only 100 μV. is available across a shunt for the measurement of current at 100 per cent level. At the same time a resolution and repeatability of 0·1 per cent of amplitude (and 0·1° of phase angle at amplitude levels greater than 10 per cent) has been aimed at, with an absolute accuracy of 1 per cent and 1° at the base frequency. Such stringent requirements call for a bridge method of measurement.

For voltage measurement a voltage derived from the network is compared in a transformer with an internal reference signal. The latter is derived from a three-phase master oscillator through a magslip phase shifter and a potentiometer amplitude adjustor. The same oscillator energizes the network through phase shifters and potentiometers in active units representing generators. The difference of the two signals is derived from the transformer and provides the input to a servo-system which adjusts the shafts of the reference phase shifter and potentiometer until the reference signal becomes equal in phase and magnitude to the unknown voltage and the error signal disappears. The phase and magnitude of the network voltage (referred to a phase of the master oscillator) are then indicated on dials ganged with the shafts of the reference phase shifter and potentiometer. The current bridge is identical except for a difference in the operating level.

The shafts of both bridges drive the elements of a small analogue computer, also servo-operated, which indicates the products $P = VI \cos \varphi$ and $Q = VI \sin \varphi$. Here φ is the direct phase angle between the voltage V and current I measured, and hence P and Q represent the active and reactive volt-amperes.

Although the equipment is for use primarily in the service of the electrical industry, it is intended that so far as possible its versatility and flexibility shall be made available for the solution of problems within its range irrespective of their origin.

FAMILY PLANNING

IN an article on family planning*, Dr. Philip M. Bloom discusses the principles of family spacing which have been commonly accepted by most civilized communities. Besides accounts of the 'safe' period and the more usual methods of contraception like the condom and cervical cap, Bloom discusses investigations now being made into the development of oral contraceptives. At present, research is along four lines. In the first place an anti-fertility substance, phosphorylated hesperidin, is being investigated. It is thought that the sperm liberates an enzyme, hyaluronidase, which acts on the capsule of the newly-discharged ovum in such a way as to allow penetration and fertilization by the sperm. Phosphorylated hesperidin is a non-toxic inhibitor of hyaluronidase; an American worker has administered it orally to three hundred couples in an attempt to control fertility. He claims much success but corroboration is needed.

Secondly, an anti-fertility factor of an entirely different nature is that contained in the plant, *Lithospermum ruderale*. It is likely that it either inhibits the secretion of the pituitary gonadotrophic hormone or neutralizes it. Dried extracts of *Lithospermum* used on laboratory animals of both sexes have reduced fertility; nothing is really known of its effects on human beings. In England, a gromwell (*Lithospermum officinale*) has been found to contain this anti-fertility factor, and properly prepared extracts are non-toxic. They permit the possibility of trials in human volunteers. A third line of research is that of finding substances such as anti-vitamins or anti-hormones which will prevent development of the ovum or curtail its ability to embed itself in the endometrial lining of the uterus. Fourthly, there is the possibility of active immunization. An antigen which would produce immune bodies in the female capable of preventing either fertilization or nidation offers interesting speculation. Langer in New York has used such an antigen in female mice. With extracts of human umbilical cord given in three weekly injections, he found that female mice brought into contact with fertile males following a wait of three weeks showed delays in producing young in about 80 per cent of cases. Further, some of these substances may act as early abortifacients and would not be readily accepted by large sections of society. Others, by interfering with ovulation, would produce irregularities in menstrual cycles which may cause considerable emotional upsets in women. A great deal of further research work has to be done before an easy oral contraceptive is discovered and accepted; but it is probable that at some future time such a substance will be found.

* *Health Education Journal*, **12**, No. 2; April 1954.

SALMON MIGRATION AND THE ENVIRONMENT

By Prof. A. G. HUNTSMAN
Fisheries Research Board of Canada and University of Toronto

WHAT fish do of themselves is simple enough; but where they go is greatly complicated by environment and weather. This is a general conclusion from twenty years investigation of salmon and other fishes with the view of their management. Where they go is basically important in management and needs to be predicted.

Where salmon go may, as is most natural for us, be considered psychologically in the belief that they go where they will, and they are free to go anywhere in the water. Or it may be considered physiologically in the belief that their internal processes determine where they go, and physiology has now the highest repute among zoologists. But, to follow either of these courses is to reckon without one's host. The host in this case is the environment. Claude Bernard concluded that living is the continuous adjustment of internal conditions to external: "Ce n'est point par une lutte contre les conditions cosmiques que l'organisme se developpe et se maintient; c'est, tout au contraire, par une adaptation, un accord avec celles-ci"[1]. This means that the environment sets the pace, that it determines living.

If we can rid ourselves of preconceived ideas, there is no mystery in salmon migration. It is easy to see that the anadromous salmon is carried downstream and swims back up, and that the katadromous eel swims upstream and is carried back down. It is also easy to see that fish are carried downstream when they wander and do not resist the current sufficiently by heading and swimming upstream, and also that, when wandering vigorously, they head and swim

upstream under the stimulus of being carried over the bottom by a current. Closeness of their relations with the bottom, which provides the stimulus, determines whether they go upstream or downstream. That the fish may keep down from too much light near the surface of the water, and up from close contact with the bottom, means variety in the stimulus for ascent. Heading upcurrent, avoidance of strong light and avoidance of solid or hard boundaries can be observed generally in animals that move about in water or in air, and these behaviours may be considered as simple and basic, no matter how complicated may be their psychology or their physiology.

The following account briefly summarizes what has just been worked out for our best example of fish migration. The details will be given in a bulletin on fish and fishery management that is in preparation for the Fisheries Research Board of Canada.

The Margaree River of Cape Breton Island happens to have particularly good conditions for developing a rather complete picture of the migration of the local salmon, even for the sea portion when they are for the most part deep in the water and out of sight. When small salmon or parr that live for several years in the river are swept into the sea by heavy floods, they reach the Margaree estuary. They survive where the water is not so salt as to kill parr. Thereupon they ascend small streams tributary to the estuary[2]. When adult Margaree salmon are tagged after spawning and are liberated in the estuary in the autumn, they may or may not (depending upon floods) ascend the river and be found in it as late as the middle of the next summer. Finally, they are found only in the sea, and, until they have again become fat and vigorous, only along the outflow of the river for ten or twenty miles to the north-east along the coast[3]. Fat salmon that have ceased feeding and are wandering vigorously have been tagged and liberated as caught in traps on the Margaree coast. The individuals go in every direction in the sea, as shown by their recapture wherever there is gear to take them[4,5]. As a whole, however, they are shifted by the water movements. They may be concentrated near the shore by near-surface currents from onshore winds, or concentrated near the mouth of the estuary by the return subsurface current that replaces the sea water entrained in the outflow. They are shifted both offshore and onshore as well as to and fro along the coast by wind currents. Native Margaree salmon are thus bandied about by the weather, and in this way, as well as by wandering, become widely dispersed, as was shown by recaptures of individuals from a lot of more than 30,000 that were marked by fin-clipping when they were descending as smolts in 1938. Some of these were tagged as fat 3-sea-year fish in 1941 from various nets along the coast. Recaptures made in the sea showed movement only away from the river as it happened, and the only recaptures in the river were of fish that had been in the concentration close to the mouth of the estuary[6]. It must be understood that salmon do not readily enter the Margaree estuary, few of the fish that begin to wander vigorously in June being taken in the river before August or September in most years. There is nothing to prevent them entering, and they might let themselves be carried in with flooding tide and remain.

The young Margaree salmon become smolts in the spring and descend to the sea after two years in the lower warmer parts of the river system and after three years in the upper cooler parts. They descend when it becomes warm enough for them to be quite active and when light and low water do not keep them so close to the bottom that they are stimulated to head and swim upstream. Their behaviour in tidal waters with plenty of room can be observed when they are in the broad and shallow estuary before being carried out in the stronger currents and deeper water of spring tides. They are to be seen dispersed over the bottom, each one occupying a station and feeding on passing plankton while stemming the tidal currents that fluctuate in strength and change in direction every six hours or so. It may safely be presumed that they do this where they are carried by the estuarial outflow to deep water, in which they descend out of sight.

Knowledge of where they settle when carried seaward in the outflow and dispersed is necessarily very limited. Fishermen occasionally catch salmon on their baited hooks when fishing in the outflow and at depths as great as thirty fathoms or more. Only when the salmon cease feeding and, on wandering, become concentrated near shore or in the outflow is it profitable to fish for them. Few of them do this as grilse after a year in the sea. Most of them do it after two years, and a considerable number after three years. The nets used have a mesh size suitable for capture of these larger fish. When those marked as smolts in 1938 appeared as 2-sea-year fish in 1940, they were at first found only in the outflow and from six to twenty miles along the coast from the estuary mouth. They were more abundant near the inner than near the outer end of this zone, which is evidently where they had settled as smolts. The river had, as usual, declined in flow during June of 1938 when they descended, which meant that the 3-year-old smolts from upper cooler waters would not on the whole be carried as far seaward as the 2-year-old smolts. Correspondingly, as study of the scales of the fish showed, the former dominated among the salmon taken at the inner end of the zone of their primary distribution in the sea and the latter dominated at the outer end. As the fishing season progressed, this difference decreased as a result of mixing from wandering of individuals to and fro in every direction. A similar situation existed in 1941, when these marked native Margaree salmon appeared as 3-sea-year fish. However, they appeared later in the season than the 2-sea-year fish had done and along a greater part of the outflow. These facts indicated that the 3-sea-year fish had settled farther offshore in deeper and cooler water, where they would mature more slowly and be exposed later in the season to vernal warming. Where they settled had determined their remaining a longer time in the sea and reaching a greater size. On the whole, this was farther from the estuary mouth, so that the 3-sea-year fish had a smaller percentage that had been 3-year-old smolts than had the 2-sea-year fish. The relative distribution of 3-year-old and 2-year-old smolts along the outflow as shown by the adults varies with the river discharge during the period of their descent. In 1933, the discharge fluctuated greatly and did not decline very markedly. It has been found that, as a result of this, 3-year-old smolts were not dominant among the salmon from the smolts of that year that were taken near the estuary mouth in 1935 as 2-sea-year fish and in 1936 as 3-sea-year fish. Ordinarily they would be dominant among salmon taken near the estuary mouth, as was true for the 3-sea-year salmon of 1935 and for the

2-sea-year salmon of 1936, which were from smolts descending in 1932 and 1934, respectively, when the river discharge declined steadily and markedly. With marked decline, the 3-year-old smolts in arriving late would not find where they settled near the estuary mouth the ground already occupied by so many younger, but not smaller, fish.

In conclusion, it may be stated that, while individual fish may quickly reach and enter the river (one even returning from Newfoundland), entrance of the adult stock into the estuary depends on the whole upon the fish being carried into the estuary or close to its mouth. Also, ascent of the river from the estuary depends, as is well known, upon freshets, which stimulate the fish to greater activity.

[1] Bernard, Claude, "Leçons sur les phénomènes de la vie" (Paris, 1878).
[2] Huntsman, A. G., *J. Fish. Res. Bd. Can.*, **6**, 399 (1945).
[3] Huntsman, A. G., *J. Fish. Res. Bd. Can.*, **6**, 311 (1945).
[4] Huntsman, A. G., *Bull. Fish. Res. Bd. Can.*, 57 (1939).
[5] Huntsman, A. G., *Pub. Amer. Assoc. Adv. Sci.*, **8**, 32 (1939).
[6] Huntsman, A. G., Ann. Rep. Fish. Res. Bd. Can. for 1941, 37 (1942).

PAPER CHROMATOGRAPHY AS A TOOL FOR MOSQUITO TAXONOMY: THE *CULEX PIPIENS* COMPLEX

By DR. DON W. MICKS

Laboratory of Medical Entomology, Department of Preventive Medicine and Public Health, University of Texas Medical Branch, Galveston

THE taxonomy of mosquitoes is well advanced by comparison with that of most groups of insects, and yet there remains a number of problems which cannot be solved by ordinary taxonomic methods. This is particularly true of the *Culex pipiens* and *Anopheles maculipennis* complexes, where recognition characters are insufficient to distinguish between the various members of the group. Recently, the *Culex pipiens* complex has been the object of intensified and concerted efforts on the part of taxonomists, geneticists and others, in order to establish the exact relationship of the mosquito populations which comprise this group[1]. It is apparent, however, that neither taxonomic nor biological differences have been sufficiently significant to provide an accurate basis for distinguishing between members of the complex. Without adequate morphological discontinuities, it is obvious that the problem must be approached with additional methods.

To provide a more discriminating tool for mosquito taxonomists and to learn more about mosquito–parasite relationships, we initiated the biochemical approach to the problem with the application of paper chromatography to the study of mosquito extracts[2]. It was possible to demonstrate that different genera of mosquitoes exhibit markedly different patterns of free amino-acids. The purpose of the present communication is to show that, with a revised and simplified technique, it is possible to demonstrate consistent biochemical differences between members of the *pipiens* complex used in this study.

American *Culex pipiens* (Illinois), *C. fatigans* (California) and *C. molestus* (Germany) were maintained as laboratory colonies, whereas European *C. pipiens* were collected as adults in Pavia, Italy. The adults of all species except the latter were used at two to three days of age, unfed. For some experiments, mosquito extracts were prepared according to previously described methods[3] for obtaining free amino-acids. When whole mosquitoes were used, the wings and legs were removed and the bodies boiled for two minutes in distilled water to coagulate the protein. Excess water was removed and the bodies mashed on the chromatographic paper with a glass rod. Four adult female mosquitoes were always used to make one preparation. The spot produced by each specimen was allowed to dry before adding the next in order to keep the material confined to a small area. Propanol and 1 per cent ammonia (2 : 1) was the solvent used for all one-dimensional chromatograms, and the different strains were always run in duplicate. Two-dimensional chromatograms were run with phenol as the first solvent and butanol–acetic acid and water (4 : 1 : 1) as the second. Whatman No. 1 filter paper was used for all chromatograms. All sheets were allowed to remain in the solvent for 16 hr. at 22–25° C. Those run in phenol were dried in the oven at 80° C., whereas all other chromatograms were allowed to dry at room temperature. All were sprayed with 0·2 per cent ninhydrin in water-saturated butanol.

Chromatograms of four extracts of each member of the *pipiens* complex used, as well as those of whole boiled mosquitoes, revealed consistent differences in their ninhydrin-positive patterns. One-dimensional chromatograms in propanol–ammonia showed eleven ninhydrin-positive spots for all species. As can be seen in Fig. 1, the patterns representing each of the forms studied are similar except for spots 6, 7, 8 and 9, where there are striking differences in the density of colour. Spot 6, which does not photograph well due to its yellow colour, is always more intense in *fatigans* than *pipiens*. On the other hand, spots 7, 8 and 9 are consistently darker in the latter species. The pattern of *molestus* is similar to that of *fatigans*, except the latter exhibits less intense spots, 7, 8 and 9.

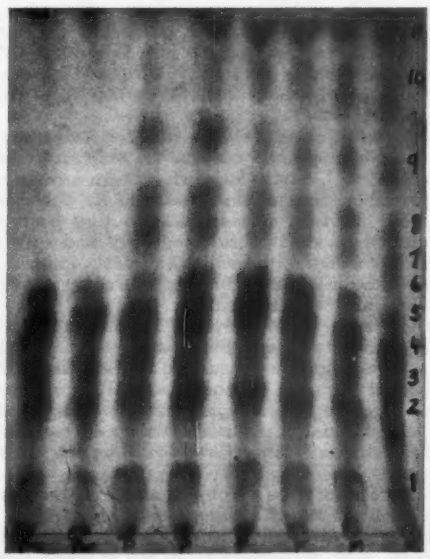


Fig. 1. One-dimensional chromatogram of specimens of European *C. pipiens*, PW; American *C. pipiens*, P; *C. fatigans*, F, and *C. molestus*, M, run in duplicate

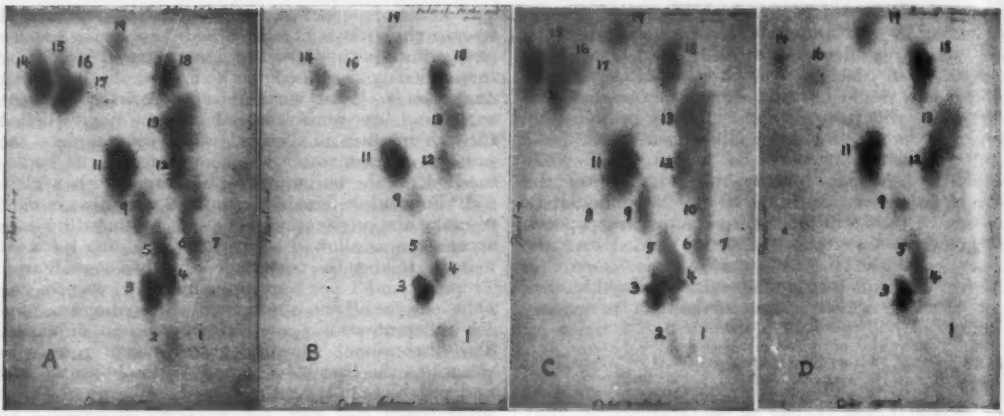


Fig. 2. Two-dimensional chromatograms of extracts. (*A*) *C. pipiens* (American); (*B*), *C. fatigans*; (*C*), *C. molestus*; and (*D*), *C. pipiens* (European)

The European *pipiens* present an interesting pattern inasmuch as they show the greatest amount of proline (spot 6) of all the forms studied, and yet spots 7, 8 and 9 are practically absent. The extracts presented essentially the same pattern.

For better and more accurate comparison of certain ninhydrin-positive substances, two-dimensional chromatograms were run with extracts. Fig. 2 compares chromatograms of the different members of the *pipiens* complex studied. At the level of concentration used, sixteen to nineteen spots representing free amino-acids appeared on chromatograms of extracts of the four different forms. Actually, fewer ninhydrin-positive areas than this are seen in Fig. 2, since some spots developed after the photographs were made. Although in general the patterns are similar, striking differences in amino-acid concentration are seen in certain areas as judged by the density of colour. For example, spots 2 and 7 do not appear on the chromatogram of European *pipiens*, and the latter spot is also absent in *fatigans*. One of the most significant differences may be seen in spot 19, which is markedly more dense in European *pipiens* in spite of the relatively low concentration of other amino-acids.

It appears from the results thus far obtained that paper chromatography may be an extremely useful taxonomic tool, particularly when there are no good morphological recognition characters for the species involved. In fact, it may well be that such biochemical methods as chromatography and infra-red spectrophotometry[3] present the most consistently accurate means of distinguishing between populations of mosquitoes within a complex.

Whole mosquitoes provided material equally as good as extracts for one-dimensional chromatography and without the time-consuming methods and special equipment required for the latter. This method is thereby a simplification of that previously used[2]. Far less material is required than for extracts, since a chromatogram can be run with as few as four specimens. Furthermore, the propanol–ammonia solvent does not have the objectionable characteristics of phenol and the chromatograms dry rapidly.

It is not yet known how the ninhydrin-positive patterns vary with the age of the specimens used. On a few occasions adults of two weeks of age have been used with no apparent alteration in the characteristic pattern. The European *pipiens*, however, which have all been collected from the basement of a building during the winter, were probably one to two months old. The relatively small quantity of ninhydrin-positive substances seen in the chromatograms of these specimens, therefore, may reflect a lowered metabolic rate or a partial depletion of certain amino-acids. Although all the forms used in the present study contain the same amino-acids (including glutamine) as previously determined with other strains[3], no attempt has yet been made to identify the substances which appear on the one-dimensional chromatograms.

This work on members of the *Culex pipiens* complex is being continued and extended to the *Anopheles maculipennis* complex.

The work described in this communication was carried out under a Fulbright Research Grant. I am indebted to the Istituto di Zoologia, Università di Pavia, for the use of facilities and equipment. Thanks are due to Dr. J. B. Kitzmiller, of the University of Illinois, for kindly supplying three strains of *Culex* used in this work. [April 11.

[1] Mattingly, P. F., Rozeboom, L. E., Knight, K. L., Laven, H., Drummond, F. H., Christophers, S. R., and Shute, P. G., *Trans. Roy. Ent. Soc. Lond.*, **102**, 331 (1951). Mattingly, P. F., Shute, P. G., Laven, H., and Knight, K. L., Trans. IX Int. Cong. Ent., **2**, 285 (1953).

[2] Micks, D. W., and Ellis, J. P., *Proc. Soc. Exp. Biol. and Med.*, **78**, 69 (1951); **79**, 191 (1952).

[3] Micks, D. W., and Benedict, A. A., *Proc. Soc. Exp. Biol. and Med.*, **84**, 12 (1953).

NEW TYPES OF INTERFERENCE FILTERS OF GREATER AREAS AND HIGHER CONTRAST

By A. HERMANSEN

Physics Department, Royal Veterinary and Agricultural College, Copenhagen

IN a previous communication[1] the principles were outlined for the production of interference filters $ML_{2m}M$ of the Fabry–Perot type with transmission bands at definite wave-lengths (M means silver layers and L_{2m} means a layer of a dielectric

with low index of refraction and with an optical thickness of $2m.\frac{\lambda}{4}$). Briefly, the method consists in measuring the thickness of the dielectric layer during evaporation by measuring in reflexion polarimetrically the phase difference $\Delta = \delta_p - \delta_s$ of the components of the electrical vector parallel (E_p) and perpendicular (E_s) to the plane of incidence at a definite angle of incidence of 75°.

During the past three years, this method has been further developed both theoretically and experimentally, and has been used to control the production of new types of interference filters, especially compound interference filters $M'L_{2m}M''L_{2m}M''L_{2m}M'$ with four silver layers and three dielectric layers.

A new evaporation plant was built in 1951 for the purpose of production of filters with a diameter up to 25 cm. to be used for astrophysical purposes. The diameter and height of the steel bell jar were 60 cm. and 80 cm., respectively. The evacuation of the container was carried out by a 9-in. silicone oil diffusion pump. The filter blank (glass plate) was rotated during evaporation by a small motor placed outside the container, by means of magnetic coupling acting through a brass plate. The distance between the evaporation source of the dielectric and the centre of the filter blank was 68 cm. By this arrangement it has been possible for a filter up to 25 cm. in diameter to obtain a constant thickness of the dielectric layer with an accuracy better than 0·5 per cent.

On the steel bell jar were welded side tubes carrying plane windows at such angles that a perpendicular transmission of the polarized light beam was secured. By this arrangement the polarimetrical quantities $\Delta = \delta_p - \delta_s$ and $\tan \Psi = \rho_p/\rho_s$ resulting from reflexion at the filter layers can be measured directly during the evaporation and employed for control of the thickness of the dielectric layers[1]. In the green–yellow spectral region these polarimetric measurements can be carried out visually by means of a λ/4-mica plate (Senarmont compensator) combined with a half-shade arrangement. Recently, however, a photoelectric method due to Clegg, Archard and Taylor[2] has been adopted. By this method, using a rotating analyser and a Wollaston prism, it is possible to read Δ and Ψ directly without use of either compensator or half-shade arrangement and to measure in the infra-red as well as in the visible.

For most of the filters cryolite was chosen as a dielectric, because of the experimental difficulties of using magnesium fluoride, due to its higher melting point. However, the optical properties of cryolite depend greatly upon the conditions of evaporation, especially the index of refraction, which depends upon the speed of evaporation (rate of growth of the layer). With a rapid evaporation, a value of n as low as 1·27 will result. With a very slow evaporation (more than 1–2 hr.) n turns out to be as high as 1·34. The index of refraction is determined by measurements of $\Delta_{min.}$ and $\Delta_{max.}$ during evaporation.

Only with very slow evaporation can a stable interference filter be made with cryolite as dielectric material.

Magnesium fluoride is more difficult to evaporate in the rather large quantities required by this apparatus. Again, with rapid evaporation n may be as low as 1·28 (measured in vacuum). However, a few hours after the filter has been removed from the container, n increases to 1·38 and a stable filter results.

Interference filters of the Fabry–Perot type $ML_{2m}M$ have the disadvantage that about 0·5 per cent or more of light with a wave-length far from the transmission band passes through the filter. The contrast is given by

$$\frac{I_{max.}}{I_{min.}} = \left(\frac{1+R}{1-R}\right)^2 \text{ (at } R = 0{\cdot}85;\ \frac{I_{max.}}{I_{min.}} = 152). \quad (1)$$

Dufour[3] has developed a theory for filters with three silver layers, $M'L_{2m}M''L_{2m}M'$. The contrast factor of such a filter is about 2000 (at 5500 A.). However, for many practical purposes the contrast factor is still not high enough.

For these reasons it was decided to try to construct filters of a still more complicated type $M'L_{2m}M''L_{2m}M''L_{2m}M'$, consisting of four silver layers and three dielectric layers. For such compound filters it is important to know what thicknesses of the silver layers M' and M'' will give optimum conditions. In the theory, the following notations are used: R_2 and T_2 are the reflecting power and the transmitting power of the central silver layers M'', and δ_2 and β_2 the phase shifts at reflexion and transmission, respectively, at normal angle of incidence of silver layers M''. R_1 and T_1 are the reflexion and transmission power of the outer silver layers M'. Introducing the important quantity

$$\sigma \exp i\alpha = 1 - \frac{T_2}{R_2} \exp i2(\beta_2 - \delta_2),$$

it can now be deduced from the fundamental equations for thin films that the transmission as a function of wave-length $I(\lambda)$ is given by:

$$I(\lambda) = \frac{(T_1T_2)^2}{|\{1 - R.\exp(-iy_1)\}^2 - R_2.\exp(-iy_2)\ \{1 - \sigma R.\exp(-i(y_1 - \alpha))\}^2|^2}, \quad (2)$$

where $R = \sqrt{R_1R_2}$; $y_1 = \frac{4\pi d_1 n}{\lambda} - \frac{(\delta_1 + \delta_2)\pi}{180}$; $y_2 = \frac{4\pi d_2 n}{\lambda} - \frac{2\delta_2.\pi}{180}$;

d_1 is the thickness of the outer dielectric layers and d_2 that of the centre dielectric layer.

If $y_1 = y_2$ and if the approximation $\alpha = 0$ is made, it can be deduced from (2) that $I(\lambda)$ will only have one peak (of a definite order) if the relation

$$2R_1(R_2.\sigma)^2 + \sqrt{R_1R_2}\,(1 + (R_2\sigma)^2 - 6R_2.\sigma^2) + 2\sigma R_2 \geqslant 0 \quad (3)$$

is satisfied. If this quantity is negative, as in the case of four silver layers of equal thickness, more peaks (of the same order) will result (Fig. 1, *D*). If only one peak is present, the peak transmission $I_{max.}$ and the contrast factor $I_{max.}/I_{min.}$ can be deduced from equation (2):

$$I_{max.} = \frac{(T_1T_2)^2}{((1-R)^2 - R_2(1-\sigma R)^2)^2} \quad (4)$$

$$\frac{I_{max.}}{I_{min.}} = \left(\frac{(1+R)^2 + R_2(1+\sigma R)^2}{(1-R)^2 - R_2(1-\sigma R)^2}\right)^2 \quad (5)$$

To compare the applicability of such compound filters $M'L_{2m}M''L_{2m}M''L_{2m}M'$ with filters of the usual type $ML_{2m}M$, some results from numerical calculations will be given. All the quantities occurring in equations (2–5) can be calculated when the index of refraction of the silver layers and of the dielectric

Table 1

λ / $\nu - i\varkappa$	t'' / t'	R_2 / $R_1(3)$	$I_{max.}$ (4)	$\frac{I_{max.}}{I_{min.}}$ (5)	σ / α
6560 A. 0·13 − i 4·27	500 A. 205 A.	0·940 0·685	0·41	5·3 × 10³	1·0225 −0·228°
5500 A. 0·15 − i 3·36	500 A. 225 A.	0·895 0·608	0·34	0·8 × 10³	1·0422 −0·575°
4360 A. 0·17 − i 2·33	500 A. 250 A.	0·788 0·474	0·28	0·5 × 10⁴	1·1074 −1·874°

layers and the thicknesses t' and t'' of the silver layers M' and M'' are known. The results are given in Table 1 and in Figs. 1–3.

In Table 1, t' is calculated in such a way that only one peak results (equation (3) equal to zero) and it is assumed that $n = 1{\cdot}35$.

In Fig. 1 and Fig. 2 intensity (calculated directly from equation (2)) is plotted against wave-length for different thicknesses t' and t'' of the silver layers for the red, and in Fig. 3 for the green, spectral regions. The small negative value of α gives rise to a small displacement of the peak towards the violet compared with the peak of the filters $M'L_2M''$ and $M'L_2M''$ and gives rise to an asymmetrical curve. This asymmetrical curve is most pronounced for a filter with four silver layers of equal thickness (Fig. 1, *D*). Comparison of Fig. 1 and Fig. 2 shows that the thickness of the inner silver layers t'' has to be somewhat greater than for a filter $ML_{2m}M$ to get a reasonable band-width of such a filter. In these numerical calculations, a table for the addition of complex numbers[4] has been of great value.

Some filters of this compound type for different wave-lengths have been produced, the polarimetric method[1] mentioned being well suited to control the thickness of the three dielectric layers on the base of the filter. The thickness of the silver layers M' and M'' is determined by means of transmission measurements with test plates. The filters produced seem to confirm the theory. Filters (20 cm. × 20 cm.) with peak transmission as high as 0·35–0·40 have been produced having a transmission less than 0·001 at a wave-length 500 A. from the peak (second order).

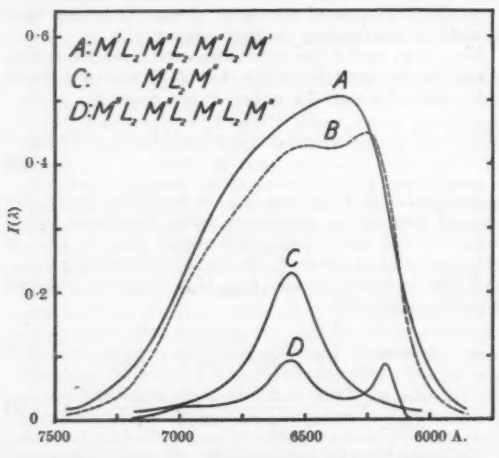


Fig. 1. Calculated curves for compound interference filters $M'L_2M''L_2M''L_2M'$. The thickness of the inner silver layers is $t'' = 400$ A. for all the curves. The thickness of the outer layers t' is: *A*, 158 A., *B*, 205 A., and *D*, 400 A. The thickness of the dielectric layers is chosen in such a way that the filters $M'L_2M''$ and $M''L_2M''$ both have peak transmission at 6560 A. ($R_2 = 0{\cdot}90$; $T_2 = 0{\cdot}05$; $\sigma = 1{\cdot}0536$; $\alpha = -0{\cdot}462°$)

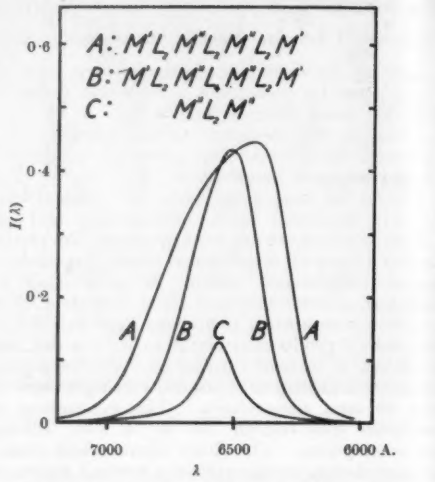


Fig. 2. Calculated curves for two compound interference filters $M'L_2M''L_2M''L_2M'$ and $M'L_2M''L_2M''L_2M'$ compared with the Fabry–Perot filter $M''L_2M''$. $\nu - i\varkappa = 0{\cdot}13 - i\,4{\cdot}27$, $n = 1{\cdot}35$, $t'' = 500$ A. and $t' = 205$ A. The thicknesses of the dielectric layers are chosen in the same way as in Fig. 1

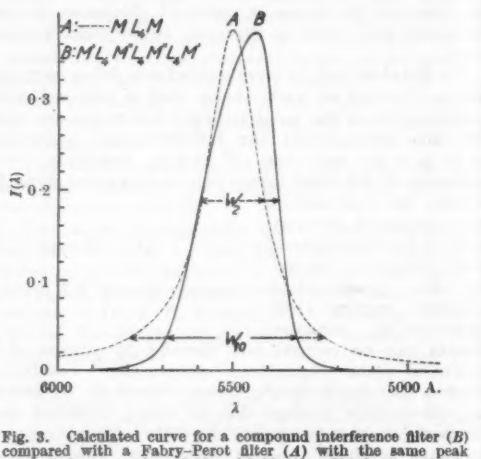


Fig. 3. Calculated curve for a compound interference filter (*B*) compared with a Fabry–Perot filter (*A*) with the same peak transmission. $\nu - i\varkappa = 0{\cdot}15 - i\,3{\cdot}36$. $t'' = 500$ A., $t' = 225$ A. for the compound filter and $t = 360$ A. for the Fabry–Perot filter. Both filters are of the second order

Some filters of this compound type for different wave-lengths have been produced, the polarimetric method[1] mentioned being well suited to control the thickness of the three dielectric layers on the base of the filter. The thickness of the silver layers M' and M'' is determined by means of transmission measurements with test plates. The filters produced seem to confirm the theory. Filters (20 cm. × 20 cm.) with peak transmission as high as 0·35–0·40 have

A more detailed account of this work will be published elsewhere.

I wish to thank Prof. Bengt Strömgren, director at the Royal Astronomical Observatory, Copenhagen, who made the construction of the larger evaporation plant possible. I am also grateful to Prof. Ebbe Rasmussen, the director of this laboratory, for many valuable discussions and for his interest in this investigation; finally, I wish to thank Mr. P. W. Streander for the construction of the apparatus. [Dec. 28.

[1] Hermansen, A., *Nature*, **167**, 104 (1951).
[2] Archard, J. F., Clegg, P. L., and Taylor, A. M., *Proc. Phys. Soc.*, **65**, No. 394 B, 774 (1952).
[3] Dufour, C., *J. Phys. et le Radium*, **11**, 413 (1950).
[4] Rybner, Jørgen, and Sørensen, K. Steenberg, Table for Use in the Addition of Complex Numbers (Jul. Gjellerups Forlag, København, 1948).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Dawn and Dusk Flight of *Drosophila subobscura* Collin

FEW records exist of insects with two peaks of activity in 24 hr. Of the many identified species attracted to a light in four years of continuous trapping, only one, a moth *Pterophorus monodactylus*, was caught at two separate times each night[1]. *Aphis fabae* has a double peak of emigrant flight from its secondary host, and this is the result of a complex chain of moulting rhythms, weather influences and flight behaviour[2]. A fall has been observed in the number of *Simulium venustum* in the air when evaporation-rate was high, leaving density maxima at 09.00 and 18.00 hr.[3]. Several species of Drosophilidae have been caught at bait traps with maximum numbers at dusk and dawn both in Europe and America[4–6]; but many factors, including humidity, will affect the area of influence of these traps and hence the number of insects caught and possibly their time of arrival.

Many insects have been caught by suction trap[7] at Rothamsted, but none shows such a striking bi-modal periodicity as the Drosophilidae (several species of *Drosophila* and *Scaptomyza*). Specimen catches for *D. subobscura* on two days of contrasting weather in July and on a dull day in October are recorded in Fig. 1. These density values are absolute and are not artificially stimulated by bait or light; the ordinate is the mean density of insects per *c.* 10,000 cu. ft. of air during the 30 min. abscissa intervals. The depressing effects of adverse weather on aerial density can be seen in the July histograms and the shift in time of flight with a shorter day in the October catch. Despite differences in trapping site, weather, times of year and population density, the two peaks remain quite distinct, with no flight either in complete darkness or bright daylight.

This is curious, because the Schizophora (Diptera), apart from the Drosophilidae, are mainly day-flying insects, and the Drosophilidae have apposition eyes usually associated with good directional vision in daylight; *D. subobscura*, in particular, cannot mate without light, at least in the laboratory[8]. Its crepuscular activity therefore seems anomalous. However, in wild-type *D. melanogaster*—which has a similar periodicity—there is a shift in the spectral sensitivity of the eye to shorter wave-lengths when light intensity is low[9]. This will tend to increase the relative efficiency at dawn and dusk.

Drosophilidae are highly susceptible to desiccation[10], and those that live in humid sub-tropical forests have a more flexible periodicity than species found typically in open country[5].

It is interesting to speculate that *Drosophila* may have become adapted to increasing daytime aridity not by increased resistance to desiccation, as must have happened to most Schizophora, but by increased visual efficiency to low light intensities, together with a shift in flight periodicity to less climatically extreme but darker times of day. In this context the observation on *Simulium venustum* already mentioned is especially interesting.

Further analysis of the observations, now in progress, may reveal how far flight behaviour alone is responsible for the periodicity. Emergence rhythm also may be involved as in *Aphis fabae*, though this seems unlikely as it has a single daily maximum and few virgins were caught; but it may partly explain the difference sometimes found between the morning and evening sex ratios (see Fig. 1).

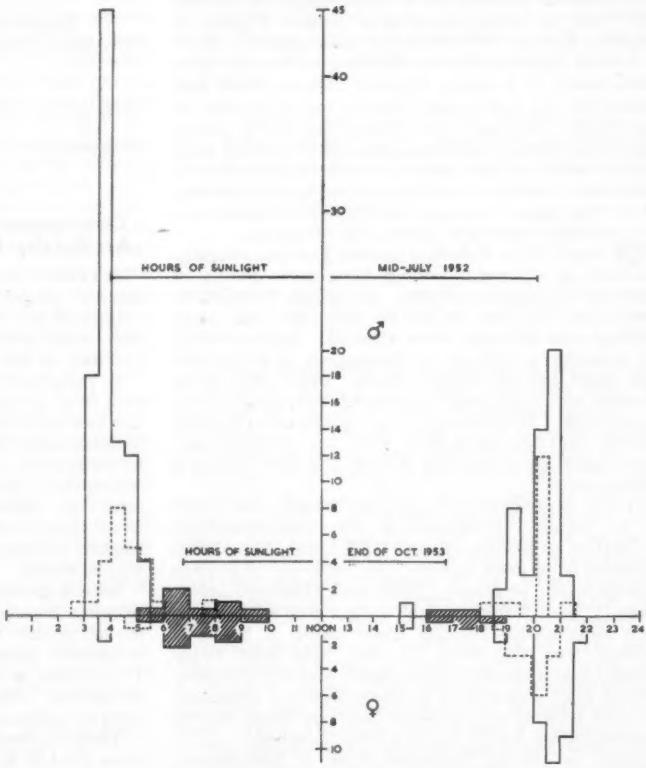


Fig. 1. Numbers of *Drosophila subobscura* caught in a suction trap at Rothamsted, Herts

———: On July 10, 1952, a fine day: the mouth of the trap placed level with the top of a bean crop in a walled garden at Rothamsted Lodge. – – – –: catch of July 23, 1952, a dull day: the trap sited as above. ////////: catch of October 28, 1953: the trap placed 3 ft. 6 in. above ground-level, in an orchard at Rothamsted Manor House; dull, slight drizzle

We would like to thank Dr. E. B. Basden, of the Institute of Animal Genetics, Edinburgh, for confirming the identification of *D. subobscura*.

L. R. Taylor

Department of Entomology,
Rothamsted Experimental Station,
Harpenden, Herts.

H. Kalmus

Galton Laboratory,
University College,
London.

April 13.

[1] Williams, C. B., *Trans. Roy. Ent. Soc. Lond.*, **89**, 79 (1939).
[2] Johnson, C. G., *Biol. Rev.*, **29**, 87 (1954).
[3] Davies, D. M., *Canad. J. Zool.*, **30**, 287 (1952).
[4] Dobzhansky, T., and Epling, C., Carnegie Inst. Wash., Pub. 554 (1944).
[5] Pavan, C., Dobzhansky, T., and Burla, H., *Ecology*, **31**, 36 (1950).
[6] Hadorn, E., Burla, H., Gloor, H., and Ernst, F., *Z. indukt. Abst. Verer.*, **84**, 133 (1952).
[7] Taylor, L. R., *Ann. App. Biol.*, **38**, 582 (1952).
[8] Rendell, J. M., *J. Genet.*, **46**, 287 (1945).
[9] Fingerman, M., and Brown, F. A., *Science*, **116**, 171 (1952).
[10] Lilleland, O., *Biol. Bull. Woods Hole*, **74**, 314 (1938).

An Epizootic among Laboratory Stocks of the Desert Locust, *Schistocerca gregaria* Forsk

D'Herelle[1] isolated a small Gram-negative bacillus from dead or dying *Schistocerca pallens* Thunb. in Yucatan, Mexico. He considered this organism, which he named *Coccobacillus acridiorum*, to be the etiological agent of a highly virulent disease which was responsible for widespread destruction of locusts in this region. Although he claimed success in locust control by means of the organism, other workers were less successful and the method was finally abandoned. Later, there was some confusion as to the true identity of *Coccobacillus acridiorum*; but Steinhaus[2] states that it is probably related to *Aerobacter aerogenes*.

The Anti-Locust Research Centre, London, recently reported an epizootic among laboratory stocks of *Schistocerca gregaria*, Forsk, in which mortalities were often as high as 80–90 per cent per cage, although not all cages were affected. Ante-mortem, the condition is difficult to distinguish in a crowded cage until shortly before death, when the insect becomes moribund with spasmodic twitching of the appendages. Post-mortem, the integument darkens and the eyes become a deep red; the abdomen and appendages are extremely flaccid and the viscera a viscous mass.

In our experiments the typical disease was found to be serially transmissible by intrahæmocœlic inoculation of healthy locusts with tissue suspensions prepared from dead insects. No evidence of a virus etiology could be found; Seitz and 'Gradocol' membrane (0·70 μ) filtrates of infective tissue suspensions were innocuous. On the other hand, a bacterial etiology was suggested by the facts that blood cultures taken shortly before death almost invariably yielded pure cultures of a Gram-negative organism, and that after death smears of blood or tissue showed Gram-negative bacilli in very large numbers.

There is strong evidence that a non-lactose-fermenting Gram-negative bacillus is the etiological agent of this epizootic disease. Such an organism has been isolated from every case of the typical disease, but in only one of 150 healthy locusts was it found. Intrahæmocœlic inoculation of less than ten of these organisms invariably produces death. Locusts fed on food sprayed with broth cultures of the bacillus showed mortalities of 70–90 per cent, and the cannibalization after death by healthy locusts of insects inoculated with the organism was sufficient to start an epizootic disease giving rise to a similar mortality-rate.

The identity of the organism has not yet been established, though it is probably a paracolon. It seems possible that the organism originally isolated by D'Herelle may resemble the causative agent of the disease briefly reported here, and that D'Herelle's organism was afterwards confused with other strains. A second Gram-negative lactose-fermenting bacillus was often isolated from dead locusts; but on only one occasion was it isolated from a sick locust prior to death. Massive doses of this organism are needed to kill, and feeding experiments result in mortalities similar to those resulting from the feeding of food sprayed with sterile nutrient broth (namely, 5–20 per cent). This organism, which is probably *Aerobacter aerogenes*, can regularly be isolated from the gut, and must be regarded as a normal member of the gut flora.

It is hoped to publish detailed results of this work in the near future.

J. P. Stevenson

Department of Zoology,
University College, London,
and the
Department of Bacteriology,
University College Hospital Medical School,
London.

June 29.

[1] D'Herelle, F., *C.R. Acad. Sci., Paris*, **152**, 1413 (1911); **154**, 623 (1912).
[2] Steinhaus, E. A., "Principles of Insect Pathology", 282 (McGraw-Hill, 1949).

Conception in Prepuberal Mice following Artificially Induced Ovulation and Mating

Superovulation in prepuberal mice is a recommended procedure for obtaining unfertilized mammalian ova[1]. Experimental results[2] have indicated that, after fertilization, these ova approximate to the viability of ova from spontaneous ovulations.

In previous studies, fertilized eggs were not obtainable from prepuberal donors since sexual receptivity did not accompany ovulation. The present report demonstrates that administration of gonadotropic hormones can be followed by ovulation, mating and conception. Since, however, conception in prepuberal mice has seldom led to pregnancy, fertilized eggs from these animals have been transplanted into mature recipients. Such eggs have developed into viable young.

Mice approximately 35–40 days old were given a priming injection of pregnant mare's serum, 1 I.U. 60 hr. before the desired time of ovulation. An ovulatory injection of human chorionic hormone, 1 I.U., was given 13 hr. before the desired time of ovulation. Observations upon conceptions in prepuberal mice are given in the following experiments.

These injections were administered to 37 female mice (Table 1, *A*); strain 129; 34–41 days old; 12–17 gm. in weight. At the time of the ovulatory injection (4.30 p.m.), each female was caged with an adult male. The following morning, 34 of the 37 females (92 per cent), showed evidence of having mated (that is, presence of vaginal plugs). The 34 females were subjected to laparotomy at 32 hr. after

Table 1. Observations on Mice following Artificially Induced Breedings

Sample	No. ♀♀ injected	No. ♀♀ with plugs	No. ♀♀ with eggs	No. eggs	No. 2-celled eggs
A	37	34	34	188*	130 (69 per cent)
B	10	10	10	63	62 (98 ")
C	10	10	9	60	57 (95 ")
D	10	9	7	53	25 (47 ")
E	14	12	11	73	59 (81 ")
Totals	81	75	71	437	333 (76 ")

* Only right oviducts were examined. Remainder of data includes observations on both right and left oviducts.

ovulation. The right oviducts were excised and all were found to contain eggs. Cleaved eggs were found in 31 of the 34 right oviducts. A total of 188 eggs were isolated, of which 130 (69 per cent) were in the 2-cell stage.

The 31 animals that possessed cleaved eggs in the right oviducts were divided into two groups. One group, 16 animals, was autopsied three and a half days after ovulation and the remainder, 15 animals, were examined eight days after ovulation.

Of the 16 uteri that were excised and irrigated at three and a half days after ovulation 15 yielded 69 eggs. Forty-five eggs (65 per cent) were typical blastocysts. These particular blastocysts were discarded; but we have reported previously[3] that eleven blastocysts similarly produced have been transplanted to a mature recipient. Six of the eleven blastocysts survived through birth and five were raised to maturity. Our experience has indicated that eggs transplanted from prepuberal mice are no less viable than eggs transplanted after spontaneous ovulations.

The 15 animals that were examined at eight days after ovulation showed no indication of uterine implantations. Similar experiments have been repeated many times, and only occasionally (less than 10 per cent of mated animals) has there been evidence of implantation. Although our results demonstrate that induced ovulation and mating is a reliable source of viable, fertilized eggs, these events have not regularly led to implantation in prepuberal mice.

The procedure for obtaining conception in prepuberal mice has been re-tested using mice of strain 129 (Table 1, *B* to *E*). Females in four subsequent samples were managed differently from those in sample *A*, in so far as they were introduced into pens with males 2 hr. before the expected ovulation and allowed to remain for 5 hr. Copulation occurred in 86–100 per cent of the females, and these mated animals were autopsied 24–36 hr. after ovulation. The mean numbers of eggs in four samples (*B*–*E*) fell between 6·3 and 7·6, and the ratio of eggs that were in the 2-celled stage varied from 47 to 98 per cent. The five samples of prepuberal mice from inbred strain 129 have shown that induced ovulation and mating occurred in 71 out of 81 animals. Recovery of 437 eggs showed that development had been initiated in 76 per cent of the eggs. Conception in prepuberal mice has provided viable fertilized eggs for a variety of experiments.

Meredith N. Runner
Allen Gates
Roscoe B. Jackson Memorial Laboratory,
Bar Harbor, Maine.
March 31.

[1] Runner, M., *Anat. Rec.*, **106**, 313 Abst. (1950).
[2] Runner, M., and Palm, J., *J. Exp. Zool.*, **124**, 303 (1953).
[3] Runner, M., and Gates, A., *J. Hered.*, [**45**, 51 (1954)].

Transport of Chloride in the 'Symplasm' of *Vallisneria* Leaves

Vallisneria leaves exposed to light show a fairly constant chloride absorption[1]; by secretion into the vacuole, the osmotic value of the cell sap is enhanced. If a part of the leaf is in contact with a chloride solution, the chloride is introduced into the cytoplasm and is translocated through it to the rest of the leaf. The chloride can be accumulated in the vacuoles in any part of the leaf that is exposed to light. If the absorbing zone is in the light and the rest of the leaf, here called the 'free part', in the dark, there is no noticeable transport and all the chloride absorbed remains in the absorption zone. If this zone is in the dark and the free part exposed to light, accumulation in the absorption zone is smaller and that in the free part much larger. This points to a transport in the cytoplasm and a secretion into the vacuoles under the influence of light[2].

A new experiment for studying the transport in the cytoplasm of the parenchyma cells is described here. In the first phase (16 hr.) of the experiment, chloride ions are accumulated in the first zone (2·5 cm.) of the leaf strips (7·5 cm.). Then the leaf strips are put into water, and a redistribution of the chloride over the other zones can be observed. In this second phase the first zone is in the dark and the free part of the leaf in the light. This difference in the exposure to light is essential to get a redistribution. The amount of chloride present in the different zones 2·5 cm. in length was determined after 8 hr. and 24 hr.

Redistribution of Chloride in *Vallisneria* Leaves

First phase, uptake during 16 hr. Second phase, redistribution after 8 hr. and 24 hr. Values in the table give the amount of chloride absorbed by 8 leaf zones of 2·5 cm. length and 0·4 cm. width

Uptake	Zone 1 0·002*M* KCl (+$CaSO_4$) in the light (γCl)	Zone 2 water in the dark (γCl)	Zone 3 water in the dark (γCl)	Whole strip (γCl)
16 hr.	208	12	5	225
Redistribution	**in the dark in water**	**in the light in water**	**in the light in water**	
8 hr.	189	26	19	234
24 hr.	172	45	16	233

It is apparent from the table that in the first zone chloride is leaking into the cytoplasm from the vacuoles in which it was accumulated before. As this zone is darkened, there is no further secretion into the vacuoles to restore the chloride content. The chloride is transported in the cytoplasm to the other zones of the leaf which are exposed to light and where secretion brings the chloride from the cytoplasm into the vacuoles. The leakage is continued during the 24 hr. of the experiment. It is remarkable that the chloride contents of the whole leaf strip remain unaltered, no chloride being lost to the outer solution; only the distribution is changed by changing the exposure to light of the different zones. The transport in the cytoplasm from cell to cell over a length of 7·5 cm. without loss to the outer solution indicates that plasma connexions between the cells must exist. The cells behave like a 'symplasm'.

This experiment is in good agreement with former results[3] obtained with inhibitors such as potassium cyanide and 2,4-dinitrophenol, and indicates that three distinct processes have to be taken into consideration: uptake in the cytoplasm, translocation through the cytoplasm and secretion from the cytoplasm into the vacuole. The leakage of the

vacuoles is a new factor which, though small, is quite definite.

Full details about these experiments will be given elsewhere.

W. H. Arisz

Botanical Institute,
Groningen.
March 21.

[1] Arisz, W. H., *Proc. Kon. Ned. Akad. Wet.*, **50**, 1019 and 1235 (1947).
[2] Arisz, W. H., *Proc. Kon. Ned. Akad. Wet.*, **51**, 25 (1948).
[3] Arisz, W. H., *Acta Botanica Néerl.*, **1**, 506 (1953).

Structural Analogies of Pox Viruses and Bacteria

Dawson and McFarlane[1] reported that the pepsin-digested elementary body of vaccinia reveals a nucleus-like central body surrounded by a membrane. This phenomenon was confirmed by subsequent papers for vaccinia[2,3] and other viruses of the pox group—fowl pox[3,4], neurovaccinia[3], ectromelia[3] and myxoma[3,5]. Pepsin digestion does not interfere with the deoxyribonucleic acid content of the virus, as shown by an earlier report[6]. In analogy to cells of higher organisms and bacteria, the structure containing deoxyribonucleic acid had to be looked for in the central body. Therefore, we attempted to digest specifically the central body by pure enzymes, as we did with the nuclei of rod-shaped and coccoid bacteria (*Escherichia coli*[7] and *Neisseria sicca*[8]).

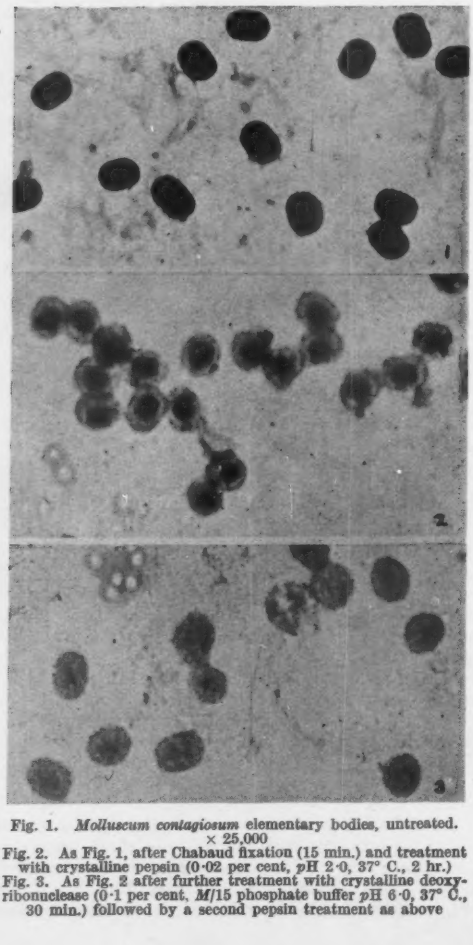


Fig. 1. *Molluscum contagiosum* elementary bodies, untreated. × 25,000

Fig. 2. As Fig. 1, after Chabaud fixation (15 min.) and treatment with crystalline pepsin (0·02 per cent, *p*H 2·0, 37° C., 2 hr.)

Fig. 3. As Fig. 2 after further treatment with crystalline deoxyribonuclease (0·1 per cent, *M*/15 phosphate buffer *p*H 6·0, 37° C., 30 min.) followed by a second pepsin treatment as above

Elementary bodies of *Molluscum contagiosum* taken from specific lesions by dabbing[9] (Fig. 1) were fixed in Chabaud solution and treated with crystallized pepsin at *p*H 2. As in other pox viruses, most of the elementary bodies were degraded and showed a more or less opaque central body of varying size and shape (Fig. 2). Earlier findings[1] that the central bodies of pepsin-treated virus particles become less opaque by treatment with deoxyribonuclease could not be confirmed, because of the variable density of these bodies. But when the deoxyribonuclease treatment was followed by a second pepsin treatment, the mass of the central body was hydrolysed, leaving an almost empty membrane (Fig. 3), thus showing that pepsin will not digest the proteins of the central body unless the protection afforded by deoxyribonucleic acid is rendered ineffective by the depolymerizing action of deoxyribonuclease; this finding was borne out by similar observations on deoxyribonucleoproteins of higher organisms (see ref. 10).

So far as the effect of these enzymes is concerned, there is obviously no dissimilarity between the central body of pox viruses and the nuclear structure of bacteria[7,8]. The virus membrane left after enzyme treatment resembles in many respects the empty wall of a bacterial cell.

A full report of this work will be published elsewhere[11]. Analogous results were obtained with vaccinia virus[12], in which we have studied the morphological variation of the central body (unpublished work).

We acknowledge the assistance of the Deutsche Forschungsgemeinschaft.

D. Peters
W. Stoeckenius

Virus Department,
Tropical Institute,
Hamburg.
April 3.

[1] Dawson, I. M., and McFarlane, A. S., *Nature*, **161**, 464 (1948).
[2] Peters, D., and Nasemann, T., *Naturwiss*, **39**, 306 (1952).
[3] Peters, D., and Nasemann, T., *Z. Naturforsch.*, **8b**, 547 (1953).
[4] Lépine, P., Atanasiu P., and Croissant, O., *C.R. Acad. Sci., Paris*, **228**, 1068 (1949).
[5] Farrant, J. L., and Fenner, F., *Aust. J. Exp. Biol. Med. Sci.*, **31**, 121 (1953).
[6] Hoagland, C. L., Lavin, G. I., Smadel, J. E., and Rivers, T. M., *J. Exp. Med.*, **72**, 139 (1940).
[7] Peters, D., and Wigand, R., *Z. Naturforsch.*, **8b**, 180 (1953).
[8] Wigand, R., and Peters, D., *Z. Naturforsch.* (in the press).
[9] Peters, D., and Nasemann, T., *Z. Tropen., Parasitol.*, **4**, 11 (1952).
[10] Klingenberg, H. G., *Z. physiol. Chem.*, **290**, 139 (1952).
[11] Peters, D., and Stoeckenius, W., *Z. Tropen., Parasitol.* (in the press).
[12] Peters, D., and Stoeckenius, W., *Z. Naturforsch.* (in the press).

Isolation of *Keratinomyces ajelloi* from Soils in Great Britain

Karling[1] first used keratinaceous materials for the isolation of keratinophilic chytrids from soil and water. Similar techniques for the isolation of other keratinophilic fungi from soil have since been devised by other workers. Thus, Mandels *et al.*[2], Cooke[3] and Ajello[4] have also isolated *Microsporum gypseum* from various soil samples in the United States. Belgian soils examined by Vanbreuseghem[5] yielded no known dermatophytes, but did reveal the presence of a keratinophilic fungus which Vanbreuseghem placed

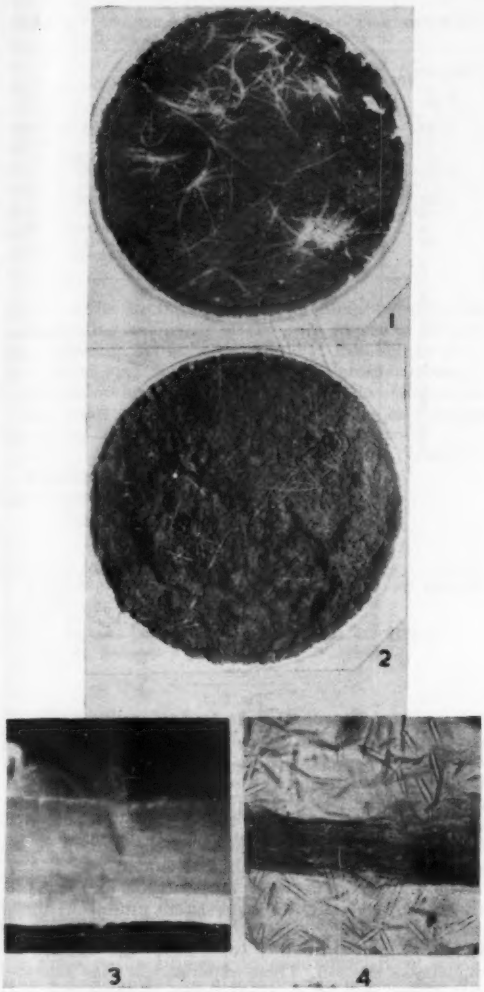


Fig. 1. Fungal growth on hairs on non-sterile soil after 8 days. (4/7 natural size)

Fig. 2. Unattacked hairs on sterile control plates after 8 days. (4/7 natural size)

Fig. 3. Perforating organ of *K. ajelloi* penetrating hair shaft. Dark background photograph. (× *c.* 95)

Fig. 4. Macroconidia produced by *K. ajelloi* growing on hair from soil plate. (× *c.* 190)

in a new genus, *Keratinomyces*, and gave the specific name of *K. ajelloi*. This organism was also isolated by Ajello[4] from one sample of soil from Tennessee and two samples from Georgia, out of a total of 116 soils collected from different localities. In this communication *K. ajelloi* is recorded for the first time in Great Britain, having been isolated from sixteen out of nineteen soil samples collected in different localities.

Soil samples were collected from the top two inches and placed in sterile tins. The method used for the isolation of *K. ajelloi* was the same in principle as that described by Vanbreuseghem[5]. For each sample six Petri dishes were half filled with soil; three of these were autoclaved at 20 lb. per sq. in. for 20 min. and served as controls. Strands of autoclaved hair were placed on the surface of the soil, and the latter moistened with sterile distilled water. The cultures were incubated at 20° C. and examined daily. After 7–14 days vinaceous buff-coloured[6] mycelium covered the strands of hair on non-sterile soil (Fig. 1); but no growth was observed on sterile control plates (Fig. 2). Hairs from the experimental plates were removed and mounted in cotton blue-lactophenol. Microscopical examination of the hairs showed various stages in digestion and penetration of the hair shaft by fungal perforating organs of the type described by Vanbreuseghem[7] (Fig. 3). Abundant macroconidia were produced by the fungus growing on the hairs (Fig. 4).

Pure cultures were obtained by transferring spores to Sabouraud's glucose agar slopes. Isolates resembled in every respect those of *K. ajelloi* isolated from Belgian soils and described by Vanbreuseghem. Colonies growing on Sabouraud's glucose agar were pale yellow-orange[6] in colour and lanose in texture and produced a dusky drab-coloured[6] diffusible pigment, although in some strains pigment only developed as the colonies aged. All strains produced abundant, multiseptate, fusiform macroconidia.

Source of soil	Type of soil	Result of examination of soil
1. Longniddry, East Lothian, Scotland		
Beechwood	Soil rich in decaying organic materials	+
Garden plot	Sandy loam	+
Foreshore	Sand	–
2. Manchester		
Garden plot in the University grounds	Clayey loam	+
3. Failsworth Manchester		
Garden plot	Clayey loam	+
4. Worsley, Lancashire		
Garden plot	Clayey loam	+
5. Oldham, Lancashire		
Garden plot in Alexander Park	Clayey loam	+
6. Huddersfield, Yorkshire		
Garden plot	Clayey loam	+
7. Saddleworth, Yorkshire		
Garden plot	Clayey loam	+
Cropped pasture	" "	+
8. Holme Moss, Yorkshire		
Eriophorum moorland	Peat	–
9. Jodrell Bank, Cheshire		
Garden plot, University of Manchester experimental grounds	Sandy loam	+
10. Alderley Edge, Cheshire		
Beechwood	Soil rich in decaying organic materials	+
11. Great Budworth, Cheshire		
Garden plot	Sandy loam	+
Cropped pasture	" "	+
12. Wolverhampton, Staffordshire		
Chicken run	Sandy loam rich in decaying organic materials	+
13. Snake Pass, Derbyshire		
Eriophorum moorland	Peat	–
14. Spalding, Lincolnshire		
Garden plot	Sandy loam	+
15. Nevin, Caernarvonshire, Wales		
Garden plot	Sandy loam	+

Key to table: + = *K. ajelloi* isolated; – = *K. ajelloi* not recorded.

The types and origins of the soils from which *K. ajelloi* was recorded are shown in the accompanying table.

I wish to thank Prof. C. W. Wardlaw for his continued interest and valuable advice. Dr. R. Vanbreuseghem, of the Institut de Médecine Tropicale Prince Leopold, Anvers, kindly confirmed my identification of *K. ajelloi*. I am indebted to Mr. E. Ashby for the photographs.

Geoffrey Daniels
Department of Cryptogamic Botany,
University, Manchester.
June 18.

[1] Karling, J. S., *Amer. J. Bot.*, **33**, 751 (1946).
[2] Mandels, G. R., *et al.*, *J. Text. Res.*, **18**, 224 (1948).
[3] Cooke W. B., *Mycologia*, **44**, 245 (1952).
[4] Ajello L., *J. Invest. Derm.*, **21** 157 (1953).
[5] Vanbreuseghem, R., *Bull. Acad. Roy. Med. Belg.*, **38**, 1068 (1952).
[6] Ridgeway, R. "Color Standards and Nomenclature", published by the author (Washington, 1912).
[7] Vanbreuseghem R *C.R. Soc. Biol., Paris*, **143**, 1302 (1949).

Effects of Antibiotics on Carbon Dioxide Production in Soil

The fate of antibiotics in soil is of great interest, partly on account of the possible importance of antibiotic substances in the development of the associations in the natural micropopulations, partly on account of the aspects of using antibiotics in the control of soil-born plant pathogens.

Gottlieb *et al.*[1] have shown that basic antibiotics like streptomycin are rapidly inactivated in soil by adsorption by the clay and the organic matter. They also found that the activity of two amphoteric antibiotics, aureomycin and terramycin, are dependent of the hydrogen ion concentration of the soil; generally they are acting as bases, being adsorbed by the clay. A neutral antibiotic, chloromycetin, was rapidly inactivated, probably by biological agencies. Jefferys[2] found that the rate of inactivation of penicillin and eight other fungal antibiotics varied from soil to soil, and considered this to be mainly an effect of *p*H on biological activity. Pramer and Starkey[3] found that decomposition of streptomycin occurred in soil and succeeded in isolating a species of *Pseudomonas* capable of decomposing streptomycin.

The effects of high concentrations of antibiotics on the complex micropopulation of the soil has been studied by determination of the evolution of carbon dioxide (by Petersen's method[4]) as a measure of the rate and extent of biological activity in soil. Five antibiotics were used: penicillin, chloromycetin, terramycin, streptomycin and aureomycin. Carbon dioxide from triplicate flasks was determined during a 14-day period at 25° C. In each of the experiments a normal Danish field soil (*p*H 6·5) was used, air-dry, with addition of 16 per cent water and 0·5–0·7 per cent of each of the five antibiotics mentioned above.

The results are shown in Figs. 1 and 2. Penicillin, chloromycetin and terramycin brought about a slight inhibition in the evolution of carbon dioxide, in the first 24–72 hr., perhaps corresponding to the lag phase. The inhibition was followed by a great rise in the production of carbon dioxide, which during the whole period amounted to approximately twice the production of the control experiments (Table 1). The excess over control corresponds to 10–20 per cent of the carbon in the amounts of the three antibiotics added.

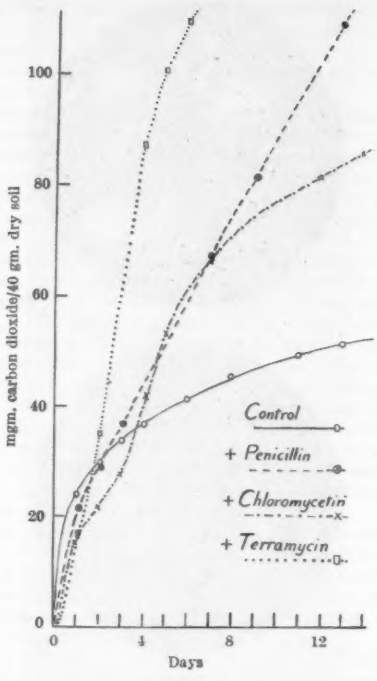


Fig. 1

The experiments with aureomycin and streptomycin showed a slight but persistent inhibition during the 14-day period, perhaps on account of the amounts added, which probably exceeded the adsorption capacity of the soil. These experiments thus indicated that there was no decomposition of these two substances within the experimental period.

Plate cultures from the soil used in the three first experiments were made on a mineral agar plus the corresponding antibiotic as the only source of carbon. In all three cases soil fungi were isolated which were

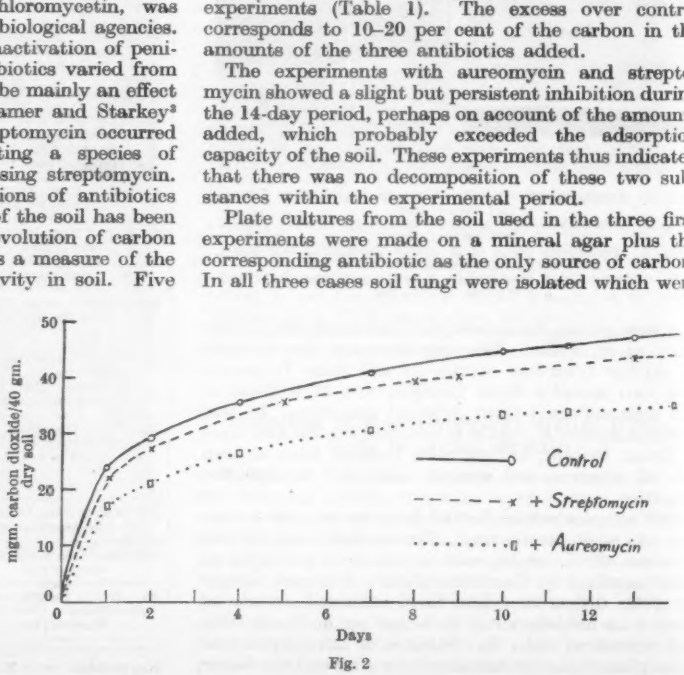


Fig. 2

Table 1. Evolution of Carbon Dioxide from the Soil (mgm. carbon dioxide per 40 gm. dry soil)

		Penicillin	Chloromycetin	Terramycin
Control		51·2	47·8	56·8
Antibiotic added		112·6	85·2	148·7
Excess	Carbon dioxide (mgm.)	61·4	37·4	91·9
	Carbon (mgm.)	16·5	10·2	25·1
	Per cent of carbon added in the antibiotic	14	10	20

able to grow in liquid synthetic medium with the corresponding antibiotic as the only source of carbon. The following types were found: Penicillin-exp.—*Penicillium* sp., *Fusarium* sp.; Chloromycetin-exp.—*Penicillium* sp.; Terramycin-exp.—*Penicillium* sp.

This work shows that fungi play an important part in the decomposition of antibiotics in soil.

T. Vincents Nissen

Bacteriological Department,
State Laboratory of Plant Culture,
Lyngby, Denmark.
March 30.

[1] Siminoff, P., and Gottlieb, D., *Phytopath.*, **41**, 420 (1951). Gottlieb, D., and Siminoff, P., *ibid.*, **42**, 91 (1952). Martin, N., and Gottlieb, D., *ibid.*, **42**, 294 (1952).
[2] Jefferys, E. G., *J. Gen. Microbiol.*, **7**, 295 (1952).
[3] Pramer, D., and Starkey, R. L., *Science*, **113**, 127 (1951).
[4] Petersen, E., *Tidsskrift f. Planteavl.*, **32**, 625 (1926).

Nutritive Value of Lucerne Protein Concentrates, fed with and without Cholesterol

The possibility of large-scale extraction of protein concentrates from green leaves has been raised by several workers[1]. Machinery for squeezing juice from crushed leaves has been developed, and a protein concentrate is obtained from this juice by precipitation. Little work has, however, been carried out on the nutritive value of these protein concentrates. Carpenter *et al.*[2] have shown a crude preparation from grass to be superior to groundnut meal when fed as a supplement to a low-protein cereal diet for chicks and rats. Davies *et al.*[3] found purified preparations from cocksfoot to have biological values of 46 and 61 when fed as the sole protein to rats.

We have found that lucerne is one of the most promising crops for protein extraction, and the nutritive value of lucerne concentrates has been studied in a number of experiments. Reasonable growth was obtained when a lucerne/grass protein concentrate was fed as the principal protein in a practical chick ration (18·8 per cent crude protein), in which 2·5 per cent of yeast was included[4]. However, lucerne protein concentrate has been found to be inferior to fish meal when added as the sole supplementary protein to rations composed of cereal products, minerals and concentrated vitamin supplements (15·1–16·3 per cent crude protein).

In discussion with Dr. J. Duckworth, it was suggested that the low nutritive value to chicks of lucerne protein concentrates might be due to a factor similar to that found in lucerne meal by Peterson[5], the effect of which was reduced by the addition of cholesterol to the rations. Using the gross protein value technique[6] the nutritive value of lucerne protein has been further studied.

In all trials, each of three replicates of each treatment consisted of twelve Rhode Island Red × Light Sussex pullets. These were reared from day-old on a diet complete in all known nutritional requirements, but deficient in protein. At 14 days old they were put on to the test rations, and live-weight gains and food consumption measured during the following fourteen days. The test rations were based on a mixture of cereal products, yeast, whey, minerals, vitamin concentrates of A, B_2, B_{12}, D and E and penicillin, to which were added either starch to give the 'cereal' control ration, casein and starch to give the 'casein' control ration, or protein concentrates and starch to give the 'lucerne protein' rations. Oat-feed was added to all rations to balance fibre contents, and calcium and phosphorus were also balanced. Cholesterol, when fed, was added to make up 0·3 per cent by weight of the ration. The protein concentrates were prepared by heat precipitation (80° C.) from lucerne juice at normal *p*H, with roller drying at 120° C. of the resulting coagulum.

Table 1

Supplementary protein source	Percentage crude protein	Mean weight gained in 2 weeks (gm.)	Protein utilization*	Gross protein value†
Trial A				
'Cereal' control	8·0	37·4	—	—
'Casein' control	11·2	91·8	6·53	100
Lucerne protein	11·3	63·8	3·69	57
Lucerne/grass protein	11·1	68·0	4·23	67
Lucerne protein + cholesterol	11·3	77·3	4·83	74
Lucerne/grass protein + cholesterol	11·2	72·5	4·58	70
Trial B				
'Cereal' control	9·9	49·2	—	
'Casein' control	13·6	109·0	5·03	
Lucerne protein + cholesterol	13·3	95·8	4·46	
Lucerne/grass protein + cholesterol	13·0	86·1	4·09	
Trial C				
'Cereal' control	8·1	43·2	—	
Lucerne protein + cholesterol	11·2	85·2	4·95	

* Gain in weight over 'cereal' control per gram of supplementary protein consumed.

† Least significant difference (5 per cent level) = 6·3.

In trial *A*, lucerne protein (48·4 per cent crude protein) and lucerne/grass protein (42·8 per cent crude protein), both fed with and without cholesterol, were compared with 'cereal' and 'casein' controls. In trial *B* the same samples of protein concentrates, both fed with cholesterol, were compared with the 'cereal' and 'casein' controls, all at protein-levels approximately 20 per cent higher than those of trial *A*. Trial *C* adds evidence on the nutritive value of the lucerne protein sample fed with cholesterol.

The results (Table 1) show that in trial *A* the gross protein values of lucerne and lucerne/grass protein concentrates were higher than that of groundnut meal with a value[3] of 50. The addition of cholesterol raised the gross protein values to nearly that of soya-bean meal with a value[7] of 76. The amounts of the lucerne protein rations consumed were less than those of the casein rations, possibly due to the lower palatability of the former.

It appears that the nutritive value of the lucerne protein concentrate was depressed by a factor, possibly a saponin[5], which was inhibited by cholesterol. Work is in progress on the removal of this factor from protein concentrates, and on other

methods of purification. Herbage species other than lucerne are also being studied.

S. J. Cowlishaw
D. E. Eyles
W. F. Raymond
J. M. A. Tilley

The Grassland Research Institute,
Hurley, Berkshire.

[1] Pirie, N. W., *Chem. and Indust.*, **61**, 45 (1942). Sullivan, J. T., *Science*, **98**, 363 (1943). White, J. W., Weil, L., Naghski, J., DellaMonica, E. S., and Williaman, J. J., *Indust. Eng. Chem.*, **40**, 293 (1948). Slade, R. E., Branscombe, D. J., and McGowan, J. C., *Chem. and Indust.*, 194 (1945).

[2] Carpenter, K. J., Duckworth, J., and Ellinger, G. M., *Brit. J. Nutr.*, **6**, xii (1952).

[3] Davies, M., Evans, W. C., and Parr, W. H., *Biochem. J.*, **52** xxiii (1952).

[4] Hughes, G. P., and Eyles, D. E., *J. Agric. Sci.*, **43**, 144 (1953).

[5] Peterson, D. W., *J. Biol. Chem.* **183**, 647 (1950).

[6] Heiman, V., Carver, J. S., and Cook, J. W., *Poult. Sci.*, **18**, 464 (1939). Carpenter, K. J., and Duckworth, J., *J. Agric. Sci.*, **40**, 44 (1950).

[7] Robertson, E. I., Carver, J. S., and Cook, J. W., Bull. Wash. St. Agric. Exp. Sta., No. 388 (1940).

Pentoses associated with Jute α-Cellulose

Sarkar and co-workers[1] claimed to have shown that jute α-cellulose does not contain any pentose; we showed[2], however, that xylose and arabinose are present, and this was confirmed by Adams and Bishop[3] by a different method. Recently, Mazumdar and Sarkar[4] have suggested that there is an inherent defect in the formic acid method[5] adopted by us for this purpose. As required by them, the chromatogram of α-cellulose prepared from different jute holocelluloses[6] with 17·5 per cent sodium hydroxide is reproduced in Fig. 1 to show that α-cellulose contains xylose and arabinose.

The finding of Mazumdar and Sarkar[4] that glucose hydrolysed by formic acid gives two spots has already been pointed out by us in the case of glucuronic acid[2]. The extra spots are presumably due to formates[7], which could be easily hydrolysed if the hydrolysate is purified by repeated boiling with water and drying[5] (compare G and G_1 in Fig. 2). We have already stated[2] that the extra spot could be readily differentiated from that given by pentoses by colour developed with aniline oxalate reagent; nevertheless, they find[4] one extra spot the colour and position of which are different from those of xylose and arabinose, which they attribute to these sugars although we have repeatedly pointed out[2] that these sugars were chromatographically separated and chemically identified and that the chromatogram was certainly 'over-run' (108 hours)[2]. Recently, by using the published formic acid treatment, Adams and his school[8], of the National Research Council, Canada, have found xylose very readily and also a trace of arabinose in jute α-cellulose. The formic acid method, therefore, has no inherent defect.

Fig. 1 Fig. 2

Fig. 1. Chromatogram in moist *n*-butanol for 108 hr. on Whatman No. 1 filter paper hydrolysed with formic acid (85 per cent) 3 hr. *A*, Chlorine dioxide α-cellulose; *B*, Cross and Bevan α-cellulose; *C*, Norman and Jenkins α-cellulose; *D*, chlorite α-cellulose; *S*, reference sugars—glucuronic acid, glucose, arabinose and xylose

Fig. 2. Chromatogram in *n*-butanol/acetic acid/water (4 : 1 : 5) for 96 hr. in Whatman No. 1 filter paper

X_2 and X_3, eight times (10–5 per cent) sodium hydroxide treated chlorite α-cellulose, hydrolysed with 85 per cent formic acid for 12 min. and 3 hr., respectively; G and G_1, glucose hydrolysed with formic acid (85 per cent) for 12 min., with and without proper purification, respectively; S_1, reference sugars—galacturonic acid, glucose, arabinose and xylose

The statement by Mazumdar and Sarkar[4] that jute α-cellulose must contain less than 1 per cent furfural to free it from traces of xylose is open to criticism, as their furfural values[9] of the α-cellulose prepared by a 9·3 per cent solution of sodium hydroxide as well as by their slightly modified method (both of which they claim[9] to be free from pentosan) are 1·44 and 1·23 per cent, respectively. This would appear to mean that α-cellulose prepared by both these methods and also by the A.C.S. method (2·55 per cent furfural) contains pentose and supports our findings.

Furthermore, regarding the proposed extra alternate arbitrary washings of α-cellulose with 10–5 per cent sodium hydroxide over that of the A.C.S. method, we feel that by doing so Sarkar *et al.* are not only deviating from the accepted definition of α-cellulose but also making something other than α-cellulose, as would be evident from the deterioration in colour and decrease in cuprammonium fluidity of a 0·5 per cent solution ($D = 10·4$; X_2 and $X_3 = 9·2$) after these alternate alkali washings. Yet, all the products of chlorite α-cellulose (D) after 1, 2, 4 and 8 alternate alkali (10–5 per cent) washings are found to contain readily detectable xylose and traces of arabinose, although the furfural content of the eight-times treated sample (X_2 and X_3, Fig. 2) was 0·75 per cent. Thus pentosans are associated not only with conventional α-cellulose but also with the product of α-cellulose (after repeated washings with 10–5 per cent sodium hydroxide) having a furfural content even less than 1·0 per cent, in contradiction to the later statement of Mazumdar and Sarkar[4].

When the duration of hydrolysis of a polysaccharide is as short as 12 min., besides the simple sugars, oligosaccharides are also expected to be formed, as reported by us previously[2] in the case of jute α-cellulose and shown in Fig. 2. While the detailed nature of the oligosaccharides is under investigation, Adams[10], by using the formic acid method, has also confirmed that oligosaccharides are produced. But comparing our chromatogram (X_2) with that of Mazumdar and Sarkar (X) it can be seen that although in the latter the glucose spot is very prominent, no oligosaccharide is found, which in view of the short time of hydrolysis indicates that their jute α-cellulose is easily hydrolysable to a simple sugar (glucose) without the intermediate formation of an oligosaccharide. We find this difficult to understand, especially as they have not reproduced the chromatogram of formic acid-treated glucose to enable comparison to be made with that of their jute α-cellulose.

The above results therefore support our findings that pentosans are strongly associated with jute α-cellulose. Their bearing on the structure of α-cellulose is under investigation.

D. B. Das
M. K. Mitra
J. F. Wareham

Group Laboratory,
Jardine Henderson, Ltd.,
Calcutta-1.
March 31.

[1] Sarkar, Mazumdar and Pal, *Nature*, **165**, 897 (1950).
[2] Das, Mitra and Wareham, *Science and Culture*, **18**, 249 (1952); *Nature*, **171**, 613 (1953). Das, *Textile Manufacturer*, **79**, 420 (1953).
[3] Adams and Bishop, *Nature*, **173**, 28 (1953).
[4] Mazumdar and Sarkar, *Nature*, **172**, 1047 (1953).
[5] Das, Chaudhuri and Wareham, *Science and Culture*, **18**, 197 (1952).
[6] Dorée, "Methods of Cellulose Chemistry", 352 (Chapman and Hall, London, 1947). Chattopadhya and Sarkar, *Proc. Nat. Inst. Sci. India*, **12**, 23 (1946).
[7] Heuser, "Chemistry of Cellulose", 285 (John Wiley and Sons, Inc., New York, 1944). Tarkow and Stamm, *J. Phys. Chem.*, **56**, 262 (1952).
[8] Adams (private communications).
[9] Sarkar, Mazumdar and Pal, *J. Textile Inst.*, **39**, T44 (1948).
[10] Adams (private communications).

I have some of the α-cellulose prepared in connexion with the communication in *Nature* of December 5, 1953, and will gladly send it to any interested chemist to verify our finding.

There is little to add to what Meyer has said about pure cellulose (*Nature*, **164**, 786; 1949). It is not clear which of Adams's jute fibre and jute straw (in the table) contains xylose and arabinose in the α-cellulose (*Nature*, **172**, 28; 1953).

P. B. Sarkar
(Director)

Technological Research Laboratories,
Indian Central Jute Committee,
Regent Park,
Tollygunge, Calcutta 40.

Abdominal Lymphatic Tissue as a Source of Hyperglycæmic Glycogenolytic Factor

It has been stated by Sutherland and de Duve[1] that the hyperglycæmic glycogenolytic factor of the pancreas is formed in the alpha cells of the islet tissue. Presence of an identical factor in the gastric mucosa led the same workers to suggest that the argentophil cells of the gastric mucosa, a cell-type believed by some investigators[2] to be identical with the alpha cells of the pancreas, might also be the site of formation of this factor. The recent discovery that cobalt chloride selectively destroys the alpha cells[3] but not the argentophil cells[4] has, however, thrown doubt on the morphological relationship of these cells. The specific site of formation of the hyperglycæmic glycogenolytic factor has not yet been definitely established. The investigations reported here appear to throw further light on this controversial point.

Rabbits of both sexes, average weight 1·5 kgm., were used. The hyperglycæmic glycogenolytic factor was extracted from the pancreas of four groups of animals: (*a*) normal rabbits; (*b*) rabbits treated with cobalt chloride (50 mgm./kgm. body-weight as a 5 per cent solution by intravenous injection once a day for two days); (*c*) rabbits treated with a single intravenous injection of 200 mgm./kgm. body-weight of alloxan monohydrate in a 4 per cent solution; (*d*) rabbits rendered diabetic with alloxan as in group (*c*) and then treated with cobalt chloride as in group (*b*). The hyperglycæmic glycogenolytic factor extracted from the pancreas of these four groups of experimental animals was assayed both by *in vivo* and *in vitro* methods[1]. Hyperglycæmic glycogenolytic factor extracts were first incubated with cysteine and dialysed against chloride phosphate buffer.

In the *in vitro* studies, hyperglycæmic glycogenolytic factor activity was determined on rabbit liver slices incubated in chloride phosphate buffer at 37° C. For purposes of comparison of maximal activity, commercial insulin (Lilly) was used. Varying doses of hyperglycæmic glycogenolytic factor extracts were used and the results expressed in milligrams of fresh tissue required to produce half-maximal activity[5]. The results of *in vitro* studies are given in Table 1.

Table 1. Glycogenolytic Activity of Hyperglycæmic Glycogenolytic Factor Extracts of Various Tissues on Liver Slices

Animal	Tissue	Mgm. of tissue required for half-maximal activity
(*a*) Normal	Pancreas	60
	Gastric mucosa	100
	Lymph glands	40
	Spleen	100
(*b*) Treated with cobalt chloride	Pancreas	50
	Gastric mucosa	100
	Lymph glands	40
(*c*) Alloxan diabetic	Pancreas	50
	Gastric mucosa	100
(*d*) Alloxan diabetic and treated with cobalt chloride	Pancreas	50
	Gastric mucosa	100

While histological studies revealed that in the pancreatic islets of rabbits treated with cobalt chloride most of the alpha cells were either degenerated or destroyed, the hyperglycæmic glycogenolytic factor content of these pancreases was found to be at normal levels. These observations are contrary to the claims of Van Campenhout *et al.*[3] and de Duve *et al.*[6]. The hyperglycæmic glycogenolytic factor content of the gastric mucosa from the animals of groups (*a*) and (*b*) were similarly found to be undisturbed. These features naturally raised the question of specificity of the site of formation of the hyperglycæmic glycogenolytic factor in the two organs.

With the view of correlating the existence of this factor in the two different organs studied, a search was made for the presence of some type of cells common to both. In sections of the pancreas and of the gastric mucosa of rabbits, it was frequently observed that lymphatic tissue occurred in both, either as loosely scattered clusters of cells or as regular lymph nodes. The possibility of these cells being the source of hyperglycæmic glycogenolytic factor was therefore considered.

Abdominal lymph nodes, a large group of which is situated near the ileo-coccal junction in rabbits, and also the spleen, were selected for study, and the hyperglycæmic glycogenolytic factor contents of these tissues were estimated. The results of the *in vitro* studies are given in Table 1. The extract from the abdominal lymph nodes showed marked

activity; that of the spleen also showed activity, contrary to the claims of Sutherland and de Duve[1].

In *in vivo* studies, hyperglycæmic glycogenolytic factor from 2 gm. of pancreas from normal rabbits and from rabbits treated with cobalt chloride gave a 30 per cent rise of blood sugar in rabbits. Hyperglycæmic glycogenolytic factor from 2 gm. of abdominal lymph nodes gave 35 per cent rise of blood sugar in rabbits. Previous treatment with cobalt chloride did not alter the hyperglycæmic glycogenolytic factor content of lymph nodes.

Experiments designed to localize the site of formation of the hyperglycæmic glycogenolytic factor show that it is present in pancreas, gastric mucosa, abdominal lymph nodes and spleen of rabbits both of normal and of experimental groups. The destruction of the alpha cells of the islet tissue of the pancreas has no appreciable effect on the hyperglycæmic glycogenolytic factor content of the pancreatic extract, showing that these cells are not involved in the formation of this factor. The presence of the factor in the extracts of abdominal lymph nodes and spleen suggests that its site of origin may be the lymphatic tissues distributed in the various organs studied.

We wish to thank Dr. B. Mukerji for the interest he has taken in this work.

M. R. Raja Rama Rao
N. N. De

Central Drug Research Institute,
Lucknow.
March 29.

[1] Sutherland, E. W., and de Duve, Christian, *J. Biol. Chem.*, **175**, 663 (1948).
[2] Tehver, J., *Z. mikr.-anat. Forsch.*, **21**, 462 (1930).
[3] Van Campenhout, E., and Cornelis, G., *C.R. Soc. Biol., Paris*, **1**, 45/11–12, 933 (1951).
[4] Fodden, J. H., *Amer. J. Clin. Path.*, **23**, 10, 994 (1953).
[5] Sutherland, E. W., Cori, C. F., Haynes, R., and Olsein, N. S., *J. Biol. Chem.*, **180**, 825 (1949).
[6] de Duve Christian, and Vuylsteke, Ch., *J. Physiol. (Paris)*, **45**/1, 107 (1953).

Inhibition of the 'Condensing Enzyme' of *Aspergillus niger* by Magnesium

Stern and Ochoa[1,2] found that magnesium (or manganese) was required for maximum activity of the 'condensing enzyme' (oxalacetate + acetylcoenzyme A ⇌ citrate + coenzyme A) isolated from pigeon liver, and used an assay system containing 4 μM magnesium chloride per ml. The same or similar systems have been used by others in comparing enzyme-levels in different organisms[3–5] and by us in studies of the 'condensing enzyme' of *Aspergillus niger*[6,7]. In later work with the *A. niger* enzyme, we found that magnesium ions were not required and that they were actually inhibitory. Inhibition of the *A. niger* enzyme by magnesium ions differentiates it from the avian enzyme and suggests that some of the lower specific activities reported for enzyme preparations from other organisms[3–5] may reflect the same phenomenon.

Crude extracts and second ammonium sulphate fractions (0·5–0·6 of 0–0·6 fractions) of fresh *A. niger* mycelium were prepared as previously outlined[6,7]. Crude extracts and second ammonium sulphate fractions (0·4–0·6 of 0·5–0·6 fractions) of lyophilized cells were also used as the source of the enzyme. *Escherichia coli* (0–0·6 ammonium sulphate fraction)[7] was used as the source of transacetylase. Ammonium sulphate fractions were dialysed against phosphate buffer before use. One millilitre of the assay system contained: phosphate buffer (*p*H 7·2), 25 μM; coenzyme A, 12 units; oxalacetate, 20 μM; acetylphosphate, 8 μM; L-cysteine, 4 μM; *E. coli* fraction, 0·05 ml., *A. niger* fraction, 0·2 ml. of crude extract or 0·02 ml. of ammonium sulphate fraction. Where indicated, magnesium ions were added as magnesium chloride. Incubation was at 28° for 40 min.

Table 1. Effect of Magnesium Ions on Citrate Synthesis

Enzyme preparation	Mg^{++} added	Mg^{++} content, per ml. ($\mu gm.$)	Citrate formed, per mgm. protein (μM)	Inhibition (per cent)
1. Extract of fresh cells*	–	0·2	0·17	—
	+	96·2	0·14	17·6
2. Ammonium sulphate fraction of 1†	–	0·1	3·84	—
	+	96·1	2·39	37·9
3. Extract of lyophilized cells*	–	1·4	5·00	—
	+	97·4	4·00	20·0
4. Ammonium sulphate fraction of 3†	–	0·4	31·0	—
	+	96·4	20·6	33·5

* 0·2 ml. *A. niger* preparation/ml. † 0·02 ml. *A. niger* preparation/ml.

Magnesium was determined spectrographically on dried 1-ml. samples of the complete reaction mixture (without added magnesium ions). Intensities of the magnesium line 2781·4 A. were compared with standards of magnesium chloride using a step sector.

Table 1 illustrates the inhibitory effect of magnesium ions (4 μM magnesium chloride) on four different enzyme preparations.

Fig. 1 shows the inhibition of citrate synthesis by different levels of magnesium ions when a second ammonium sulphate fraction of an extract of fresh cells was used as the source of the enzyme. Maximum inhibition (38 per cent) was attained with 4 μM of added magnesium chloride. Further increases, up to five times this level, did not alter the percentage inhibition.

We wish to thank Mr. W. Stockdale, Division of Physics, National Research Council, for carrying out

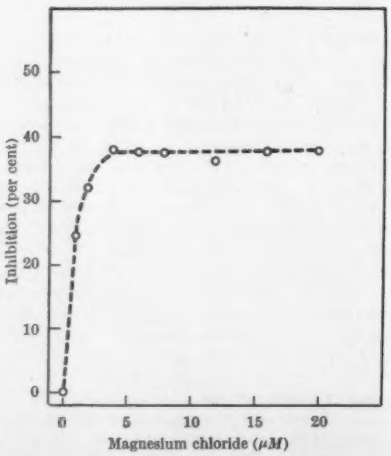


Fig. 1. Inhibition of citrate synthesis by magnesium ions

the spectrographic analyses, and to acknowledge the technical assistance of Mr. J. T. Slobodian.

C. V. RAMAKRISHNAN*
S. M. MARTIN

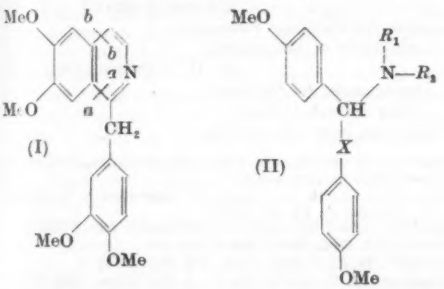
Division of Applied Biology,
National Research Council,
Ottawa. April 9.

* National Research Council of Canada Postdoctorate Fellow, 1953–54.

[1] Stern, J. R., and Ochoa, S., *J. Biol. Chem.*, **179**, 491 (1949).
[2] Stern, J. R., and Ochoa, S., *J. Biol. Chem.*, **191**, 161 (1951).
[3] Ochoa, S., Stern, J. R., and Schneider, M. C., *J. Biol. Chem.*, **193**, 691 (1951).
[4] Korkes, S., Del Campillo, Alice, Gunsalus, I. C., and Ochoa, S., *J. Biol. Chem.*, **193**, 721 (1951).
[5] Barron, E. S. G., and Ghiretti, F., *Biochim. et Biophys. Acta*, **12**, 239 (1953).
[6] Ramakrishnan, C. V., and Martin, S. M., *Chem. and Indust.*, Feb. 6, 160 (1954).
[7] Ramakrishnan, C. V., and Martin, S. M., *Can. J. Biochem. and Physiol.* (in the press).

New Synthetic Antispasmodics

A RECENT publication[1] prompts us to report the preparation of a number of novel synthetic antispasmodics related to papaverine. The numerous synthetic analogues of papaverine (I) which have been prepared (see, for example, Blicke[2]) can be divided into two main groups: (1) those with an intact *iso*quinoline ring system (for example, eupaverine[3]) and (2) those in which the *iso*quinoline ring has been opened at the line *a*—*a* to give a *bis*-(2-phenylethyl)amine (for example, sestron[4]).



A third type of papaverine analogue, obtained by opening the *iso*quinoline ring along the line *b*—*b*, does not seem to have been investigated (except that α-diethylamino-4-methoxy deoxybenzoin is reported[5] to have half the antispasmodic activity of papaverine in an isolated observation), and we now report the synthesis and activities of a series of compounds of that type.

A series of N-alkyl-1 : 2-di-(*p*-methoxyphenyl)-ethylamines (II ; $X = CH_2$), N-alkyl-α-aminodeoxyanisoins (II ; $X = CO$), and N-alkyl-2-amino-1 : 2-di(*p*-methoxyphenyl) ethanols (II ; $X = CHOH$) were prepared and, in view of the promising activity of certain 1-phenyl *iso*quinoline compounds, in which the methylene bridge was omitted (for example, neupaverine[3]), a number of N-alkyl-di-(*p*-methoxyphenyl)-methylamines (II ; $X = -$) were also synthesized for this work.

Tested on isolated guinea pig ileum against spasms produced by barium chloride and carbachol, using papaverine and atropine as standards, all compounds exhibited spasmolytic activity. In order to obtain a valid comparison, the relative potencies are quoted on a molar basis (see Table 1).

Table 1. SPASMOLYTIC ACTIVITIES

Compound II			Relative potency (molar)	Compound II			Relative potency (molar)
X	R_1	R_2		*X*	R_1	R_2	
CO	H	Me	0·9	CH_2	H	H	0·8
CO	H	Et	1·2	CH_2	H	Et	0·9
CO	H	*iso*Pr	0·3	CH_2	H	*iso*Pr	1·2
CO	Me	Me	3·3*				
CO	Et	Et	0·2*				
CHOH	H	Me	0·8	—	H	H	0·8
CHOH	H	Et	0·8	—	H	Me	1·8
CHOH	H	*iso*Pr	0·5	—	H	Et	0·8
CHOH	Me	Me	0·2*	—	Me	Me	1·1
CHOH	Et	Et	1·2*	—	Et	Et	1·0
Papaverine			1·0	—	H	*iso*Pr	0·6

* With these compounds spasm of the guinea pig ileum was induced with posterior pituitary extract.

Relative neurotropic activity was between 0·005 and 0·2 of atropine, and acute toxicities (intravenous in mice) were uniformly between 60 and 80 mgm./kgm. for all series ; that is, with an LD_{50} of two to three times that of papaverine ($LD_{50} = 30$ mgm./kgm.). In view of these promising results, these and other related compounds are undergoing further investigation, and details will be reported in full elsewhere.

We are indebted to the National Health and Medical Research Council for financial support.

J. CYMERMAN-CRAIG
K. V. MARTIN
P. C. WAILES

Organic Chemistry Department,

R. H. THORP
R. LADD
G. THORBURN

Pharmacology Department,
University of Sydney. March 31.

[1] Heinzelman and Aspergren, *J. Amer. Chem. Soc.*, **75**, 3409 (1953).
[2] Blicke, *Ann. Rev. Biochem.*, **13**, 549 (1944).
[3] Kreitmair, *Arch. Exp. Pathol. Pharmakol.*, **164**, 509 (1932).
[4] Külz and Rosenmund, *Klin. Wochschr.*, **17**, 345 (1938).
[5] Mercier, Lespagnol and Mercier, *C.R. Soc. Biol.*, **143**, 1123 (1949).

Efficiency of Oxidative Phosphorylation

THE quantitative yield of phosphate fixed during cellular oxidations deserves critical investigation, for it determines the efficiency with which utilizable energy may be derived from assimilated foodstuffs and it may influence metabolic regulatory mechanisms[1]. This problem has been the subject of many investigations (cf. Krebs *et al.*[2] and Slater and Holton[3]). In general, the observed yield has increased over a period of years as newer methods of measurement have been developed and particularly as more knowledge has been made available concerning the preparation of undamaged mitochondria which are free from interfering cellular components.

For example, Ochoa[4], in 1944, observed a phosphorus/oxygen ratio of 1·4–1·7 for the single-step oxidation of α-ketoglutarate to succinate by a dialysed extract of cat heart. By correcting for previously measured losses of high-energy phosphate occurring in the system, a value of 3 for the actual ratio was deduced. In more recent investigations with mitochondria prepared from liver heart muscle by the procedure of Schneider[5], the same oxidative reaction proceeds with measured phosphorus/oxygen ratios greater than 3 [2,6,7].

Slater, Cleland and Holton, in an extensive study of heart sarcosomes[3,8], have consistently obtained

phosphorus/oxygen ratios lower than 3 for α-ketoglutarate oxidation and have concluded[2] that values greater than 3 are in error. The over-estimation of phosphorylating efficiency is ascribed to an underestimation of oxygen consumption in the case of the work by Copenhaver and Lardy, and to a possible inherent error in the assumption by Krebs *et al.*[2] that rates of incorporation of $H^{32}PO_4^{2-}$ into adenosine triphosphate can be used to calculate phosphorus/oxygen ratios. Arguments supporting these contentions were presented *in extenso* by Slater and Holton[3] and those pertaining to our paper will be answered briefly here.

Stoichiometry of the reaction. Slater and Holton[3] find heart sarcosomes, in the presence of 0·01 *M* malonate, oxidize α-ketoglutarate beyond the stage of succinate (O/α-kg = 0·95–1·28; mean 1·13); Copenhaver and Lardy, in twenty experiments, obtained values of 0·8 to 1·1; mean, 0·975. From the low inhibition index of malonate vs. succinate, one would predict that 0·01 *M* malonate is sufficient to block succinate oxidation virtually completely. This was put to test using the experimental conditions described[6], and it was found that 5 μmoles of succinate (the average amount formed during the 15–25 min. experimental period) supported no discernible oxygen consumption above that in control flasks without added substrate. The respiration in the latter case was either zero or so low as to be an insignificant portion of that occurring in the presence of substrate. (Experiments have also shown that the hexokinase preparation used[6,9,11] does not fix inorganic phosphate in the absence of mitochondria.)

Measurement of oxygen consumption. Slater and Holton[3] consider a 5-min. equilibration period insufficient to bring the flask contents to equilibrium in the 30° Warburg bath. They cite an experiment attempting to duplicate the technique employed in this laboratory. They report that with their equipment a period of 22 min. was required to reach thermal equilibrium, that a lag in oxygen consumption occurred during the first 5 min. of measuring respiration, and that a phosphorus/oxygen ratio of 4·55 is obtained. Under our conditions (thin-walled flasks of 16 ml. volume, 3·0 ml. fluid, bath covering flasks above ground joint, shaking at 120 excursions/min. and stopcocks closed during last minute of equilibration period) thermal equilibrium is reached in 5 min. (± 2 mm. of Brodie's fluid). The complete absence of a lag period in oxygen consumption in our phosphorylation experiments is shown in eleven charts in the paper[9] accompanying that criticized by Slater and Holton.

Stability of mitochrondrial system. Slater and Holton[3] consider metal chelating agents such as ethylenediaminetetraacetic acid to be essential to stabilize the enzyme system of sarcosomes. It is possible that the higher level of adenosine triphosphate employed in our experiments (0·002 *M*) accomplishes the same result, for respiration is a linear function of time for periods of at least an hour when an adequate supply of inorganic phosphate and phosphate acceptor is present[9]. Under these conditions (Fig. 4, ref. 9) the measured phosphorus/oxygen ratios for α-ketoglutarate oxidation in the absence of agents which block the Krebs cycle is 2·8 at a 20-min. and 2·56 for a 70-min. experimental period. Slater and Holton (Table V, ref. 3) find a ratio of 1·71 for a similar unblocked system with rat heart sarcosomes prepared in saline-ethylenediaminetetraacetic acid. From this it is clear that the liver mitochondria prepared in sucrose were fixing more phosphate per unit of oxygen consumed than were the sarcosomes. As has been pointed out[3], these differences are not inherent in the two tissues, for Maley and Plaut[7] find phosphorus/oxygen ratios greater than 3 for α-ketoglutarate oxidation by heart mitochondria and Slater and Holton[3] find 2·5 for liver mitochondria.

A most critical test of the degree to which oxidation is 'coupled' with phosphorylation involves the measurement of respiration in the presence and absence of a phosphate acceptor system[10,11]. The respiration of fresh mitochondria is enhanced some four- to fifteen-fold by the addition of a phosphate acceptor or by agents such as 2,4-dinitrophenol[1,10], and, in general, systems which do not exhibit this effect have a lowered phosphorylation efficiency. It is felt that this test should be applied routinely when there is any doubt about the phosphorylating efficiency of mitochondrial preparations.

Phosphorylating efficiency during oxidation of β-hydroxybutyrate. It is generally agreed that the oxidation of α-ketoglutarate to succinate supports one more phosphorylation than does the oxidation of β-hydroxybutyrate to acetoacetate. Quantitative studies of the latter oxidation with mitochondria have yielded phosphorus/oxygen ratios between 2·4 and 3 [6,9,11]. Ratios as great as 2·5 have been measured after 180 min. equilibration[11].

These results support the view that the phosphorus/oxygen ratio for oxidation of β-hydroxybutyrate approaches 3, while that for oxidation of α-ketoglutarate to succinate approaches a value of 4.

Henry Lardy
Institute for Enzyme Research,
University of Wisconsin.

J. H. Copenhaver, jun.
Department of Zoology,
Dartmouth College,
Hanover, New Hampshire.

[1] Lardy, H., in "The Biology of Phosphorus" (Michigan State College Press, East Lansing, 1952).
[2] Krebs, H. A., Ruffo, A., Johnson, M., Eggleston, L. V., and Hems, R., *Biochem. J.*, **54**, 107 (1953).
[3] Slater, E. C., and Holton, F. A., *Biochem. J.*, **56**, 28 (1954).
[4] Ochoa, S., *J. Biol. Chem.*, **155**, 87 (1944).
[5] Schneider, W. C., *J. Biol. Chem.*, **176**, 259 (1948).
[6] Copenhaver, J. H., and Lardy, H., *J. Biol. Chem.*, **195**, 225 (1952).
[7] Maley, G. F., and Plaut, G., *J. Biol. Chem.*, **205**, 297 (1954).
[8] Slater, E. C., and Cleland, K. W., *Biochem. J.*, **53**, 557 (1953). Slater, E. C., and Holton, F. A., *Biochem. J.*, **55**, 530 (1953).
[9] Lardy, H., and Wellman, H., *J. Biol. Chem.*, **195**, 215 (1952).
[10] Potter, V. R., and Recknagel, R. O., in "Phosphorus Metabolism", 1, 377 (The Johns Hopkins Press, Baltimore, 1951).
[11] Maley, G. F., and Lardy, H., *J. Biol. Chem.*, **204**, 435 (1953).

Chemical Form of Phosphorus-32 produced in Aluminium by Bombardment with Nitrogen

Multiply-charged ions of elements up to neon have recently been accelerated to energies of the order of 100 MeV. in the Nuffield Laboratory 60-in. cyclotron at Birmingham[1]. Some of these ions have been used in bombardment studies[2]. Among the radioactive products is phosphorus-32, which is formed, for example, in relatively large yield in bombardments of aluminium-27 with $^{14}N^{6+}$ ions. We have carried out experiments designed to show in what chemical state these atoms are held in the target.

The results of the experiments indicate that on dissolving a bombarded aluminium foil in sodium

hydroxide solution in the absence of air, about two-thirds of the recovered activity is carried by gaseous phosphine and the remainder enters solution as a reduced oxy-phosphorus ion, probably hypophosphite. The proportion forming phosphate ion is undetectable without the use of drastic oxidizing conditions. We have shown that the reducing action of the aluminium on dissolving, under our experimental conditions, is insufficient to convert more than a very small fraction of previously dissolved hypophosphite to phosphine. This suggests, although it does not prove, that the radioactive phosphine is a true primary chemical reaction product.

The absence of phosphorus-32 in the form of phosphate ion indicates that the phosphorus-32 atoms, although undoubtedly initially formed with a high positive charge, do not persist in that state. On the other hand, the presence of radioactive hypophosphite ion shows that not all the phosphorus-32 atoms remain in the lattice as phosphide ions, because if this were so one would expect to get all the activity as phosphine. This suggests an intermediate valency state.

It does not seem likely that oxygen atoms adventitiously present in the target can have affected the result. Whitmore showed that when phosphorus-32 is produced by fast-neutron irradiation of thiourea or sodium sulphide, no activity appears as phosphine on treatment with air-free water; by far the larger part of the activity is found as one or other of the oxyphosphorus acids[3]. However, no special precautions were taken to exclude oxygen rigorously during the bombardment, and Koski has shown that in the production of sulphur-35 by fast-neutron reactions in potassium chloride the rigorous expulsion of occluded air enables one to observe the sulphur-35 atoms in a sulphide fraction rather than as sulphate[4]. The oxygen content of spectroscopically pure aluminium is, however, very low by ordinary standards except, of course, at the surface, and in any event it is doubtful whether phosphorus atoms could successfully compete for oxygen atoms with the aluminium.

As is well known, the reaction between ordinary elemental phosphorus and caustic alkali leads to the formation of phosphine and hypophosphite ion in the molecular ratio 1 : 3. Our results would therefore have been obtained if half the phosphorus-32 atoms had reacted as phosphide and half as elemental phosphorus. An objection to this naïve view is that one could not fairly expect an isolated phosphorus atom embedded in a foreign lattice to undergo the same reactions as in its normal elemental environment. Furthermore, we find it hard to believe that the phosphorus-32 atoms are held in the aluminium in non-equivalent states; for the lattice must be seriously disturbed by the passage of the phosphorus-32 atoms (and other reaction products and bombarding particles) before coming to rest, the total energy dissipated, in many experiments, being sufficient to raise the temperature of the target nearly to the melting point. Consequently, all the phosphorus-32 atoms must have been able to find sites of minimum potential energy.

An explanation of the observations must therefore be sought in a consideration of the chemical species which may be supposed to react with the phosphorus-32 atoms. These comprise not only water molecules, hydrogen ions and hydroxyl ions, but also hydrogen atoms produced by the reaction of neighbouring aluminium atoms with the dissolving solution. On this basis we may postulate that the phosphorus-32 atoms are all present in a very low, or even zero, state of charge, and the reaction yields reflect competition between overall reactions such as:

$$P + 3H \rightarrow PH_3\,; \qquad P + 2H_2O \rightarrow H_3PO_2 + H$$

or

$$P^+ + 4H \rightarrow PH_3 + H^+\,; \qquad P^+ + 2H_2O \rightarrow H_3PO_2 + H^+.$$

It is clear that a great deal remains to be understood about this kind of problem, and we hope, when the cyclotron is in operation again after the current reconstruction is completed, to make a more detailed investigation. We should like to thank Prof. P. B. Moon and Dr. D. Walker, of this laboratory, and Dr. A. G. Maddock, of the University of Cambridge, for useful discussions.

G. A. Chackett
K. F. Chackett

Nuffield Laboratory,
Physics Department,
The University,
Birmingham 15.
June 14.

[1] Walker, D., and Fremlin, J. H., *Nature*, **171**, 189 (1953).
[2] Chackett, K. F., Fremlin, J. H., and Walker, D., *Phil. Mag.*, (7), **45**, 173 (1954).
[3] Whitmore, F. E., *Nature*, **164**, 240 (1949).
[4] Koski, W. S., *J. Amer. Chem. Soc.*, **71**, 4042 (1949).

Methods of Calculation of Polarographic Currents for Depolarization Schemes involving Reactions of Higher Order

In the course of investigations concerning the mathematical analysis of rate-controlled polarographic limiting currents, rigorous methods have been worked out which make it possible to evaluate the rate constants of chemical reactions involved in the depolarization process, when the reactions are of the first order (for review, see ref. 1).

If the depolarization process at the dropping mercury electrode involves a reaction of the second or higher order, the depolarization current resulting from the flux of the depolarizer at the electrode surface can be calculated by solving the following general system of equations:

$$\frac{\partial a_i}{\partial t} = D_i \frac{\partial^2 a_i}{\partial x^2} + \frac{2x}{3t}\frac{\partial a_i}{\partial x} + F_i(a_1, \ldots a_n)\,; \quad i = 1, \ldots n. \tag{1}$$

$$x > 0,\ t = 0 : a_i = \alpha_i\,; \tag{2}$$

$$x = 0,\ t > 0 : D_i \frac{\partial a_i}{\partial x} = \sum_{j=1}^{n} m_{ij} a_j\,; \tag{3}$$

where the second term on the right-hand side of equation (1) accounts for the expansion of the electrode against the solution[2], x is the distance from the surface of the dropping electrode, t the time measured from the beginning of drop formation, a_i and D_i the concentration and diffusion coefficient of reactant A_i, respectively, and m_{ij} the rate constants of the electrode reactions referred to unit area; these depend on the electrode potential. Now whereas for monomolecular reactions the last term of equation (1) may be written in general

$$F_i(a_1, \ldots a_n) = \sum_{j=1}^{n} k_{ij} a_j, \quad (4)$$

this does not hold for the case of reactions of a higher order.

In view of the difficulties involved in the solution of problems of this type, the treatment will be restricted here to cases where the chemical reactions involved in the depolarization scheme are either very slow (case A) or very fast (case B).

In both cases, we first try to find linear combinations of the type

$$\psi_k = \sum_{l=1}^{n} \varkappa_{kl} a_l \quad (5)$$

which would satisfy equations of the type

$$\frac{\partial \psi_k}{\partial t} = \overline{D}_k \frac{\partial^2 \psi_k}{\partial x^2} + \frac{2x}{3t} \frac{\partial \psi_k}{\partial x}. \quad (6)$$

In case A, equations (6) as well as the equations for the remaining concentrations a_i are transformed by introducing the independent variables s_i and η[2,4]:

$$s_i = \frac{x}{\sqrt{\frac{1}{7} D_i t}}, \quad \eta = Ct. \quad (7)$$

The solution is taken to be of the form

$$a_i = \sum_{j=1}^{\infty} \varphi_j^{(i)}(s_i) \eta^j, \quad (8)$$

where the functions $\varphi_j^{(i)}$ satisfy the equations:

$$\varphi_j^{(i)\prime\prime} + 2s_i \varphi_j^{(i)\prime} - \frac{12}{7} j \varphi_j^{(i)} = g_j[\varphi_0^{(1)}, \ldots \varphi_{j-1}^{(1)}; \ldots; \varphi_0^{(n)}, \ldots \varphi_{j-1}^{(n)}]. \quad (9)$$

Here g_j can be regarded as known functions of s_i. Since the solution of equation (9) with the right-hand side equal to zero is known[2-4], the solution of the complete equations (9) presents no further difficulty. The integration constants appearing in this solution can be determined from the boundary and initial conditions (2) and (3), respectively. The mean value of the polarographic depolarization current is then calculated in the usual manner[3,4]. The successful evaluation of the specific rate of dismutation of pentavalent uranium from the limiting currents of the uranyl ion represents a special case of this general treatment[5,6].

Considering case B, it is often possible to write the differential equations (1), left after the transformation (5) in an approximate form (cf. refs. 3, 4),

$$D_i \frac{d^2 a_i}{dx^2} - \phi_i(a_i; \psi_1, \ldots \psi_m) = 0, \quad (10)$$

where $\psi_1 \ldots \psi_m$ are defined by equations (5). For small values of x, the functions ψ can be regarded as independent of x, so that:

$$D_i \left(\frac{da_i}{dx}\right)^2 = 2\int \phi_i(a_i; \psi_1, \ldots \psi_m)\, da_i + K. \quad (11)$$

Since equilibrium of the chemical reaction is established at distances from the electrode which are negligible compared with the thickness of the diffusion layer, the value of the constant K in equation (11) can be determined. Equation (11), which represents the relationship between $\partial a_i/\partial x$ and a_i, makes it possible to eliminate the functions a_i from the mathematical formulation of the problem, just as in the treatment of very fast monomolecular reactions, and thus to reduce this problem to a simpler one, which is non-linear merely in the boundary conditions. It can be easily solved by means of the transformation (7) assuming the form[3,4]:

$$\psi_j = \sum_{k=0}^{\infty} \gamma_k^{(j)} [K_{\frac{j}{2}k}(s_j) - p_{\frac{j}{2}k} L_{\frac{j}{2}k}(s_j)] \eta^{k/2} + \frac{2}{\sqrt{\pi}} \psi_j^{(0)} L_0(s_j), \quad (12)$$

where

$$\psi_j^{(0)} = \sum_{l=1}^{n} \varkappa_{jl} a_l. \quad (13)$$

For the coefficients $\gamma_k^{(j)}$ recurrent relations are obtained by substituting (12) into the boundary conditions (3). The latter method has recently been applied in mathematical analysis of polarographic limiting currents due to the electro-reduction of formaldehyde in unbuffered solutions. Under these conditions the hydroxyl ions, produced in the electrode process, catalyse the establishment of the equilibrium between the hydrated, polarographically inactive, and non-hydrated active forms of formaldehyde, the former being always in a large excess over the latter[7].

Jaroslav Koutecký
Laboratory of Physical Chemistry,
Czechoslovak Academy of Science,
Prague.
March 18.

[1] Brdička, R., *Coll. Czech. Chem. Comm.* (in the press).
[2] Koutecký, J., *Čs. časopis pro fysiku*, **2**, 117 (1952); *Czech. J. Phys.*, **2**, 50 (1953).
[3] Koutecký, J., *Chem. listy*, **47**, 9 (1953); *Coll. Czech. Chem. Comm.*, **18**, 311 (1953).
[4] Koutecký J., *Chem. listy*, **47**, 323 (1953); *Coll. Czech. Chem. Comm.*, **18**, 597 (1953).
[5] Koutecký, J., and Koryta, J., *Chem. listy* and *Coll. Czech. Chem. Comm.* (in the press).
[6] Koryta, J., and Koutecký, J., *Chem. listy* and *Coll. Czech. Chem. Comm.* (in the press).
[7] Brdička, R., and Koutecký, J., *Chem. listy* and *Coll. Czech. Chem. Comm.* (in the press).

Oxygen-18 Abundance in Fresh Water

Mass spectrometric tests of the oxygen-18 abundance, a_f, in a hundred and nine freshwater samples obtained from various parts of the world, have shown very considerable variations. When the samples are compared in relation to the climatic conditions of the area of collection, the results indicate a much decreased oxygen-18 abundance as the climate becomes colder. The deviations from a set standard ranged between $+ 32 \times 10^{-4}$ and $- 17 \times 10^{-4}$ atom per cent.

This is due, principally, to the fact that ocean-water vapour travelling towards colder regions yields precipitation the oxygen-18 abundance, a_p, of which, on account of the comparatively low vapour pressure of $H_2{}^{18}O$, is higher than the oxygen-18 abundance, a_v, of the vapour. In the remaining vapour, a_v and a_p in consequence gradually decrease. This fact has been confirmed experimentally by measurements on precipitation from warm fronts. These measurements are in agreement with the following formula, computed for variations in a_p with the temperature, $T°$ K., of the condensed vapour:

$$\Delta(\log a_p) = \Delta(c_1 + \log(c_2 + c_3 T) + c_4 \log T + \left(c_5 T - \frac{c_6}{T}\right) \times 0{\cdot}43429),$$

the c's being constants depending on a_v at the beginning of the condensation, the evaporation tem-

perature of the water, and the vapour pressures, ^{16}p and ^{18}p, of $H_2{}^{16}O$ and $H_2{}^{18}O$.

Conversely, evaporation will cause a rise in the oxygen-18 abundance, a_f, in the remaining water.

By repeated circulatory processes, consisting of drying up on account of ΔT^0 cooling, warming up and renewed saturation, fractionation takes place, whereby the oxygen-18 abundance of the vapour, a_v, converges towards a value where the deviation from the oxygen-18 abundance in the added vapour constitutes :

$$1{\cdot}22 \times 10^{-4} \times \Delta T \frac{f}{1-f} \text{ atom per cent,}$$

where f is the ratio of the absolute humidity of the atmosphere at the beginning and at the termination of the condensation.

Since

$$a_p \cong a_v \frac{^{18}p}{^{16}p},$$

the value of a_p for a certain precipitation depends on : (1) the nature of the circulatory processes earlier passed through by the atmosphere, namely, evaporation temperature, magnitude of earlier precipitations of water, and condensation temperature ; (2) evaporation during precipitation from the cloud to the ground ; and (3) origin of the vapour.

Point (3) implies that vapour from freshwater (continental vapour) is considerably lighter than ocean vapour. Thus, 106 measurements of oxygen-18 abundance in vapour, a_v, from the Copenhagen area, taken over a period extending from about April 1953 to April 1954, showed that there was a distinct correlation between a_v and deviations of the wind from the easterly direction. There were, moreover, appreciable seasonal changes in a_v in the course of the year. The deviations from a set standard varied between $+ 10{\cdot}3 \times 10^{-4}$ atom per cent in July and $- 5{\cdot}8 \times 10^{-4}$ atom per cent in February, corresponding to a more intensive cooling off in the winter season.

For a certain locality, the oxygen-18 abundance, a_f, of freshwater also depends on : (4) the proportions of water lost by drainage and by evaporation from the ground ; (5) the exchange of oxygen-18 between the ground water and substances in the ground containing oxygen.

Measurements of sixty-one samples of precipitation showed comparatively large variations in a_p (ranging from $+ 9 \times 10^{-4}$ to $+ 31 \times 10^{-4}$ atom per cent) ; however, the mean value ($+ 22 \times 10^{-4}$ atom per cent) was in agreement with that of a_f for the ground water ; consequently, points (4) and (5) can scarcely be of any significance in the conditions prevailing in Denmark.

Since the significance of point (3) for the oxygen-18 abundance, a_p, of the average precipitation can be determined from climatological data, while point (2) is of no significance in violent and/or persistent precipitation, it is possible by measurements on the precipitation, the vapour and the ground water and by noting the climatological and the geographical conditions, to arrive at a quantitative interpretation of oxygen-18 abundance for freshwater, a_f, at a given locality.

Willi Dansgaard

Biophysical Laboratory,
University of Copenhagen,
Juliane Mariesvej 30,
Copenhagen.
March 30.

Odour and Chemical Constitution

In a discussion of this problem, Dr. G. Malcolm Dyson (*Nature* of May 1, p. 831) refers to "the 'camphor-like' groups in which such diverse substances as camphor, hexachloroethane, benzene hexachloride and perchloronaphthalene have closely related odours".

Many years ago (*J. Chim. Phys.*, **35**, 331 (1938), and also 3e Congrès National des Sciences, Bruxelles ; 1950) and in my recent book, "Les Constantes Physiques des Composés Organiques Cristallisés" (Masson and Co., Paris, 1953, pp. 49–51 and p. 500), I have pointed out that most such substances belong to a natural group of organic compounds, defined by their low entropy of melting (< 5). As their molecules have a spherical shape, I proposed for them the name of 'globular compounds' ; they possess many other common properties, although as different in their chemical constitution as natural camphor, α-hexachlorbenzene and artificial camphor, $CCl_3.C(CH_3)_2OH$.

So far as I know, most compounds smelling like camphor have that configuration (methylcyclopentanol has not), but all globular compounds do not smell like camphor.

I have directed the attention of physiologists to this curious relation between the olfactory properties and the stereochemical configuration of such compounds, a relationship which is quite different from the study of small changes in the chemical constitution of organic compounds and their physiological action, as has hitherto been made.

J. Timmermans

Laboratory of Physical Chemistry,
University of Brussels. June 11.

Caution in the Use of Liquid Propane for freezing Biological Specimens

One of the recent innovations in freezing and drying technique is the use of liquid propane for rapid freezing. This material has explosive possibilities when cooled in liquid nitrogen that many investigators do not seem to realize. Liquid nitrogen boils at $- 195{\cdot}8°$ C., liquid oxygen at $- 183{\cdot}0°$ C. It is common experience that if a vapour trap is cooled with liquid nitrogen and open to the atmosphere, oxygen will condense in it. Since propane melts at $- 189{\cdot}9°$ C., in the range of temperatures between its melting point and the boiling point of oxygen it is theoretically possible to get a mixture of liquid oxygen and liquid propane.

On one occasion when I was slowly condensing propane in a flask chilled with liquid nitrogen, I obtained what appeared to be such a mixture : that is, I obtained two distinct layers of liquid in the flask, one of which had the characteristic appearance of liquid oxygen.

This experience suggested two precautions to be observed when working with liquid propane : (1) when condensing the material, to keep a sufficiently rapid flow into the condensing flask to exclude air ; (2) keep the material at all times above the boiling point of oxygen, say, above $- 180°$ C. Of course, similar precautions should be observed with other combustible materials the melting point of which is below the boiling point of oxygen.

John L. Stephenson

National Heart Institute,
Bethesda 14, Maryland.
March 9.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Scientific Officer (honours graduate, preferably with post-graduate experience in genetics), at the Plant Breeding Station—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (August 4).

Assistant (with a degree in agriculture or pure science, with special qualifications in botany or crop husbandry) in Agriculture—The Secretary, The University, Aberdeen (August 7).

General Assistant Engineer (with a degree in electrical or mechanical engineering or in physics), at the British Electricity Authorities Research Laboratories, Leatherhead, for duties which include testing, development and research work in the laboratories; and in the field in connexion with the generation, transmission and distribution of electricity—D. Moffat, Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting N/481 (August 7).

Lecturer (university graduate in physics, with teaching and/or industrial experience) in Physics, to teach to B.Sc. general degree standard—The Principal, Enfield Technical College, Queensway, Enfield, Middlesex (August 7).

Principal Scientific Officer (with a first- or second-class honours degree in engineering, or equivalent, and preferably with a knowledge of French and/or German and experience of committee work) in the Mechanical Engineering Research Laboratory (Materials Division), East Kilbride, Glasgow, to lead a team determining the mechanical properties of materials, studying fatigue, and examining machine parts which have failed in service—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S4356/54 (August 12).

Physics Lecturer (with a first- or second-class honours degree, and preferably with experience in the nuclear reactor field at the appropriate level, and teaching ability) to take charge of the Physics Course in the Reactor School—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berkshire, quoting 2/103/119 (August 13).

Assistant Lecturer in the Department of Geography and Anthropology—The Registrar, University College of Wales, Aberystwyth (August 14).

Assistant Lecturer in Zoology, and a Research Demonstrator in Zoology—The Registrar, The University, Reading (August 14).

Physicist (Ph.D. standard, and prepared to spend a considerable time abroad), to collaborate with geologists in the collection and preparation of rock samples and in the measurement of their magnetic properties over a wide area—Prof. Blackett, Physics Department, Imperial College of Science and Technology, London, S.W.7 (August 14).

Senior Physicist (with some knowledge of the chemical and biochemical procedures associated with the clinical applications of radioactive isotopes), to be responsible, under the direction of the Regional Physicist, for providing technical advice and assistance to clinical research teams using radioactive isotopes—The Administrative Officer, Board of Management for Glasgow Western Hospitals, Regional Physics Department, 9–13 West Graham Street, Glasgow, C.4 (August 14).

Lecturer (with a special interest in the strength of materials) in the Department of Mechanical Engineering—The Registrar, The University, Liverpool (August 21).

Lecturer in Applied Mathematics at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 27).

Lecturer and an Assistant Lecturer in the Department of Physics—The Registrar, The University, Manchester 13 (August 28).

Lecturer or Assistant Lecturer in the Department of Mathematics at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 30).

Chemist (with a specialized interest in analytical techniques), for a permanent academic appointment with the status of Fellow or Senior Fellow, responsible for the Analytical Section of the Department of Radiochemistry, Research School of Physical Sciences, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

Lecturer (with qualifications in cultural (including economic) geography, and ability to conduct postgraduate courses in economic, historical or colonial geography) in Geography; and a Lecturer in Chemistry, at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, August 31).

Senior Lecturer in Chemistry at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, August 31).

Senior Lecturer (with an honours degree or preferably a higher degree and, in addition, teaching and/or industrial experience in metallurgy) in Metallurgy, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, August 31).

Senior Research Fellow (with experience in wind-tunnel work) in the Department of Aeronautical Engineering, to design new high-speed laboratory equipment, and to take a leading part in research work—The Secretary and Registrar, The University, Southampton (August 31).

Scientific Officer (with a good honours degree in chemistry, biochemistry or botany, and a sound knowledge of organic chemistry and keen interest in the living plant) in the Biochemistry Section, for research on the biochemistry and metabolism of the fruit tree—The Secretary, East Malling Research Station, near Maidstone, Kent (September 7).

Assistant Lecturer (with an interest in histology) in Anatomy—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (September 11).

Lecturer or Assistant Lecturer in Geography at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 30).

Scholars (with a M.Sc. degree or equivalent research experience) in the Departments of Biochemistry, Microbiology and Physiology, John Curtin School of Medical Research, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

Chair of Agriculture, Chair of Physics, Chair of Chemistry, Chair of Botany and Chair of Zoology at Rhodesia University College, Salisbury—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 18).

Assistant Lecturer (with a degree in physics or equivalent qualifications, and preferably with industrial experience) in Natural Philosophy—The Secretary, Royal Technical College, Glasgow.

Chemical Engineer (with a first- or second-class honours degree in chemical engineering or equivalent, with considerable postgraduate experience in development work, including the design of pilot plants) at a Ministry of Supply Establishment in S.W. England, for work concerned with the development of technical processes involving semi-technical research, and the design and operation of pilot units—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F501/54A.

Demonstrator in Physics—The Registrar, The University, Nottingham.

Geologist (with an honours degree in geology) with the Falkland Island Dependencies Survey, for service at Hope Bay in the Antarctic—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/34380/TA.

Head of the Department of Organic Chemistry—The Academic Secretary, Weizmann Institute of Science, Rehovoth, Israel.

Lecturer (graduate, and able to teach agricultural botany and zoology, including entomology, to diploma standard) in Agricultural Botany—The Principal, Shuttleworth College, Old Warden Park, Nr. Biggleswade.

Meteorological Assistants (male or female) (with considerable experience in routine meteorological office work, especially the making of observations and the plotting of maps); and a Senior Meteorological Assistant (male) (able to maintain meteorological instruments and prepare climatological records), with the Bermuda Government—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M3B/34501/NF.

Senior Lecturer in Chemical Engineering, to plan new courses and laboratories—The Principal, Royal Technical College, Salford.

Senior Scientific Officer (with a first- or second-class honours degree in chemistry, or equivalent qualifications, and at least three years postgraduate experience including supervision of staff in research laboratories), to be responsible for advising technical and professional staff on safety matters in relation to laboratories, pilot plants, and production techniques, in a wide range of chemical and physical research problems—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 132/WGE/2.

Soils Research Officer (with a first- or second-class honours degree in an appropriate scientific subject, and experience in the techniques of physical and chemical analysis of soils and the interpretation of the results obtained), at the Alice Holt, Surrey, branch of the Forestry Commission, to carry out soil studies in connexion with ecological, silvicultural and pathological problems in British forestry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G254/54A.

Statistician (with suitable qualifications, and preferably experience at field trials)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Brompton Hospital Reports. Vol. 22 (1953). Pp. ix+165. (London: Brompton Hospital, Research Department, 1954.) 15s. net. [226

Library Association. Subject Index to Periodicals. January to March 1954. Pp. iv+71. (London: Library Association, 1954.) 3 quarterly issues and annual cumulation £10. (£8 8s. to members). Annual cumulation only £8 8s. (£7 to members). [226

International Tin Research Council. Report of the Tin Research Institute, 1953. Pp. 24. (Greenford, Mddx.: Tin Research Institute, 1954.) [226

Television Society. A Bibliography of Colour Television. Pp. 16. (London: Television Society, 1954.) 2s. 6d. [226

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office